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Noise Measurement Flight Test: Data/Analyses Aerospatiale AS 350D AStar Helicopter

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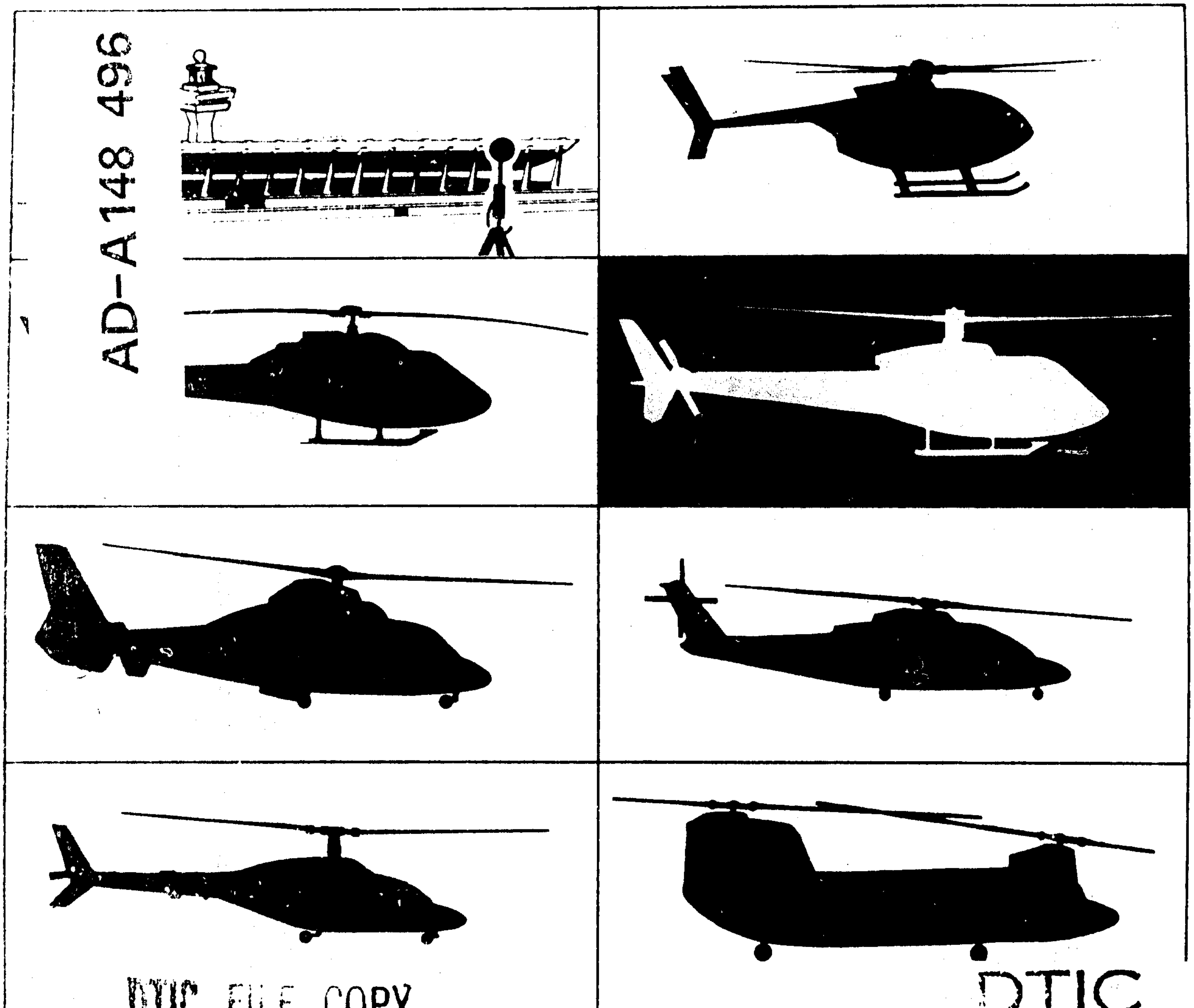

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by
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ABOUT THE COVER

The cover of this report (and other reports in this series) is comprised of silhouettes of the seven helicopters tested during the summer of 1983 at Dulles International Airport. The highlighted outline is that of the Aerospatiale AStar, the subject of this report. The helicopters shown on the cover include (clockwise from the upper right) the Hughes 500-D, the Aerospatiale TwinStar, the Sikorsky S-76, the Boeing Vertol BV-234/CH-47D, the Bell 222, the Aerospatiale Dauphin, and the Aerospatiale AStar.

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16. Abstract
This report documents the results of a Federal Aviation Administration (FAA) noise measurement flight test program with the AStar helicopter. The report contains documentary sections describing the acoustical characteristics of the subject helicopter and provides analyses and discussions addressing topics ranging from acoustical propagation to environmental impact of helicopter noise.

This report is the fifth in a series of seven documenting the FAA helicopter noise measurement program conducted at Dulles International Airport during the summer of 1983. The AStar test program involved the acquisition of detailed acoustical, position and meterological data.

This program was designed to address a series of objectives including:
1) acquisition of acoustical data for use in assessing heliport environmental impact
2) documentation of directivity characteristics for static operation of helicopters,
3) establishment of ground-to-ground and air-to-ground acoustical propagation relationships for helicopters,
4) determination of noise event duration influences on energy dose acoustical metrics,
5) examination of the differences between noise measured by a surface mounted microphone and a microphone mounted at a height of four feet (1.2 meters), and
6) documentation of noise levels acquired using international helicopter noise certification test procedures.

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helicopter, noise, AStar, heliport environmental impact, directivity, noise certification standards

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AEROSPATIALE AS 350D ASTAR

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6. Ms. Loretta Harrison for her typing and report production assistance.

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GLOSSARY

AGL	-	Above ground level
AIR	-	Aerospace Information Report
AL	-	A-Weighted sound level, expressed in decibels (See L_A)
AL_M	-	Maximum A-weighted sound level, expressed in decibels (see L_{AM})
AL_{AM}	-	As measured maximum A-weighted Sound Level
ALT	-	Aircraft altitude above the microphone location
APP	-	Approach operational mode
CLC	-	Centerline Center
CPA	-	Closest point of approach
d	-	Distance
dB	-	Decibel
dBA	-	A-Weighted sound level expressed in units of decibels (see A_L)
df	-	Degree of freedom
Δ	-	Delta, or change in value
$\Delta 1$	-	Correction term obtained by correcting SPL values for atmospheric absorption and flight track deviations per FAR 36, Amendment 9, Appendix A, Section A36.11, Paragraph d
$\Delta 2$	-	Correction term accounting for changes in event duration with deviations from the reference flight path
DUR(A)	-	"10 dB-Down" duration of L_A time history
EPNL	-	Effective perceived noise level (symbol is LEPN)
EV	-	Event, test run number

FAA	-	Federal Aviation Administration
FAR	-	Federal Aviation Regulation
FAR-36	-	Federal Aviation Regulation, Part 36
GLR	-	Graphic level recorder
HIGE	-	Hover-in-ground effect
HOGE	-	Hover-out-of-ground effect
IAS	-	Indicated airspeed
ICAO	-	International Civil Aviation Organization
IRIG-B	-	Inter-Range Instrumentation Group B (established technical time code standard)
K(DUR)	-	The constant used to correct SEL for distance and velocity duration effects in $\Delta 2$
KIAS	-	Knots Indicated Air Speed
K(P)	-	Propagation constant describing the change in noise level with distance
K(S)	-	Propagation constant describing the change in SEL with distance
Kts	-	Knots
L_A	-	A-Weighted sound level, expressed in decibels
Leq	-	Equivalent sound level
LFO	-	Level Flyover operational mode
M_A	-	Advancing blade tip Mach Number
M_R	-	Rotational Mach Number
M_T	-	Translational Mach Number
N	-	Sample Size
NWS	-	National Weather Service
$OASPL_M$	-	Maximum overall sound pressure level in decibels
PISLM	-	Precision integrating sound level meter
PNL_M	-	Maximum perceived noise level

$PNLT_M$	-	Maximum tone corrected perceived noise level
POP	-	Photo overhead positioning system
Q	-	Time history "shape factor"
RH	-	Relative Humidity in percent
RPM	-	Revolutions per minute
SAE	-	Society of Automotive Engineers
SEL	-	Sound exposure level expressed in decibels. The integration of the AL time history, normalized to one second (symbol is L_{AE})
SEL_{AM}	-	As measured sound exposure level
$SEL-AL_M$	-	Duration correction factor
SHP	-	Shaft horse power
SLR	-	Single lens reflex (35 mm camera)
SPL	-	Sound pressure level
T	-	Ten dB down duration time
TC	-	Tone correction calcualted at $PNLT_M$
T/O	-	Takeoff
TSC	-	Department of Transportation, Transportation Systems Center
V	-	Velocity
VASI	-	Visual Approach Slope Indicator
V_H	-	Maximum speed in level flight with maximum continuous power
V_{NE}	-	Never-exceed speed
Vy	-	Velocity for best rate of climb

1.0 Introduction - This report documents the results of a Federal Aviation Administration (FAA) noise measurement/flight test program involving the Aerospatiale AStar helicopter. The report contains documentary sections describing the acoustical characteristics of the subject helicopter and provides analyses and discussions addressing topics ranging from acoustical propagation to environmental impact of helicopter noise.

This report is the fifth in a series of seven documenting the FAA helicopter noise measurement program conducted at Dulles International Airport during the summer of 1983.

The AStar test program was conducted by the FAA in cooperation with Aerospatiale Helicopter Corporation and a number of supporting Federal agencies. The rigorously controlled tests involved the acquisition of detailed acoustical, position and meteorological data.

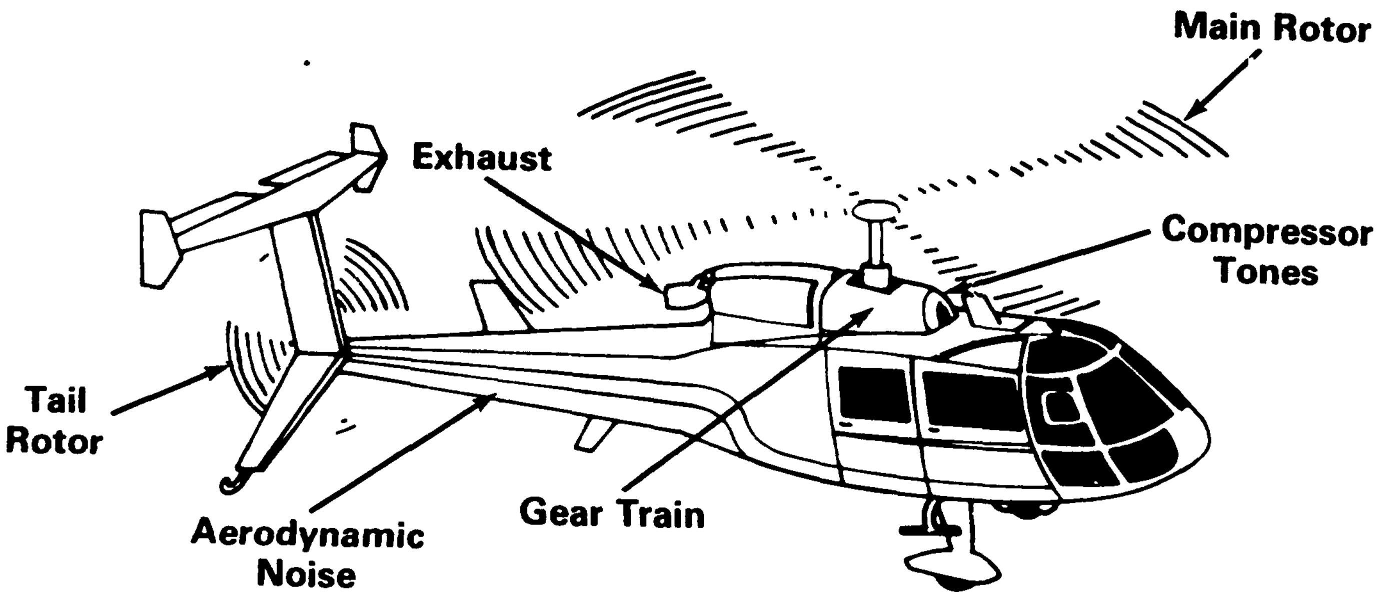
This test program was designed to address a series of objectives including: 1) acquisition of acoustical data for use in heliport environmental impact analyses, 2) documentation of directivity characteristics for static operation of helicopters, (3) establishment of ground-to-ground and air-to-ground acoustical propagation relationships for helicopters, 4) determination of noise event duration influences on energy dose acoustical metrics, 5) examination of the differences between noise measured by a surface mounted microphone and a microphone mounted at a height of four feet (1.2 meters), and 6) documentation of noise levels acquired using international helicopter noise certification test procedures.

The helicopter is a complex acoustical source generating noise from many different origins. Figure 1.1 provides a diagram identifying some of these sources. Two other noise generating mechanisms associated with forward flight effects (both producing impulsive noise) are blade vortex interaction (see Figure 9.14) and high advancing tip Mach Numbers. These figures are provided for the reader's reference.

The appendices to this document provide a reference set of acoustical data for the AStar helicopter operating in a variety of typical flight regimes. The first seven chapters contain the introduction and description of the helicopter, test procedures and test equipment. Chapter 8 describes analyses of flight trajectories and meteorological data and is documentary in nature. Chapter 9 delves into the areas of acoustical propagation, helicopter directivity for static operations, and variability in measured acoustical data over various propagation surfaces. The analyses of Chapter 9 in some cases succeed in establishing relationships characterizing the acoustic nature of the subject helicopter, while in other instances the results are too variant and anomalous to draw any firm conclusions. In any event, all of the analyses provide useful insight to people working in the field of helicopter environmental acoustics, either in providing a tool or by identifying areas which need the illumination of further research efforts.

FIGURE 1.1

Helicopter Noise Sources



TEST HELICOPTER DESCRIPTION

2.0 Test Helicopter Description - The AS 350D AStar is a light, general purpose helicopter marketed and supported by Aerospatiale Helicopter Corporation of Grand Prairie, Texas. A special feature of the AStar is Aerospatiale's "Starflex" main rotor hub, which is made of composite materials. The aircraft was designed with the idea of keeping operating and maintenance costs low as well as the noise and vibration levels. It was certificated by the FAA in December of 1977. The helicopter provides room for a pilot, copilot, and three to four passengers; there is also 35 cubic feet of baggage space. An optional ambulance layout is available.

Selected operational characteristics, obtained from the helicopter manufacturer, are presented in Table 2.1.

Table 2.2 presents a summary of the flight operational reference parameters determined using the procedures specified in the International Civil Aviation Organization (ICAO) noise certification testing requirements. Presented along with the operational parameters are the altitudes that one would expect the helicopter to attain (referred to the ICAO reference test sites). This information is provided so that the reader may implement an ICAO type data correction using the "As Measured" data contained in this report. This report does not undertake such a correction, leaving it as the topic of a subsequent report.

TABLE 2.1

HELICOPTER CHARACTERISTICS

HELICOPTER MANUFACTURER	: Aerospatiale
HELICOPTER MODEL	: AS 350D AStar
HELICOPTER TYPE	: Single Rotor
TEST HELICOPTER N-NUMBER	: 57 868
MAXIMUM GROSS TAKEOFF WEIGHT	: 4300 lbs (1951 kg)
NUMBER AND TYPE OF ENGINE(S)	: 1 Lycoming LTS 101-600A2
SHAFT HORSE POWER (PER ENGINE)	: 615 hp
MAXIMUM CONTINUOUS POWER	: 590 hp
SPECIFIC FUEL CONSUMPTION AT MAXIMUM POWER (LB/HR/HP)	: .573 lb/hr/hp
NEVER EXCEED SPEED (V_{NE})	: 169 mph (147 kts)
MAX SPEED IN LEVEL FLIGHT WITH MAX CONTINUOUS POWER (V_H)	: 145 mph (126 kts)
SPEED FOR BEST RATE OF CLIMB (Vy)	: 63 mph (55 kts)
BEST RATE OF CLIMB	: 1750 fpm

MAIN AND TAIL ROTOR SPECIFICATIONS

	MAIN	TAIL
ROTOR SPEED (maximum)	: 386 rpm	2043 rpm
DIAMETER	: 421.2 in.	73.2 in.
CHORD	: 11.8 in.	7.28 in.
NUMBER OF BLADES	: 3	2
PERIPHERAL VELOCITY	: 709 fps	653 fps
DISK LOADING	: 4.47 lb/ft^2	---
FUNDAMENTAL BLADE PASSAGE FREQUENCY	: 19 hz	68 hz
ROTATIONAL TIP MACH NUMBER (77°F)	: .6243	.5750

TABLE 2.2

ICAO REFERENCE PARAMETERS

	TAKEOFF	APPROACH	LEVEL FLYOVER
AIRSPEED (KTS)	: 55	55	113
RATE OF CLIMB/DESCENT (fpm)	: 1750	583	NA
CLIMB/DESCENT ANGLE (DEGREES)	: 18.3°	6°	NA
ALTITUDE/CPA (FEET)			
SITE 5	: 445.64/423	342/340	492
SITE 1	: 608/578	394/392	492
SITE 4	: 771/732	446/443	492
SLANT RANGE (FEET) TO			
SITE 2	: 782	630	696
SITE 3	: 782	630	696

NOTE

A preliminary comparison of noise levels (for the ICAO noise certification flight regimes) has been made by engineers from Aerospatiale Helicopters using results from previous tests in France and data presented in this report. The Aerospatiale engineers cite generally good agreement, showing the uncorrected data in this report as 1.2 EPNdB higher than French results for level flyover, 1.1 EPNdB 1 ower for approach, and 0.3 EPNdB 1 ower for takeoff operations. In the process of imlementing the full ICAO correction procedure, (in a subsequent report) a more thorough comparison will be made.

At the present time, a Helicopter Noise Measurement Repeatability Program is being cnducted by The International Civil Aviation Organization (ICAO). This program involves eight to ten different national measurement teams conducting noise tests on the same helicopter model, a Bell 206-L3. In the process of analyzing results of that program, a compendium of other comparative helicopter noise measurements will also be developed. In that context, the results reported in this document wil be compared in detail with other detailed results.

TEST SYNOPSIS

3.0 Test Synopsis - Below is a listing of pertinent details pertaining to the execution of the helicopter tests.

1. Test Sponsor, Program Management, and Data Analysis: Federal Aviation Administration, Office of Environment and Energy, Noise Abatement Division, Noise Technology Branch (AEE-120).

2. Test Helicopter: AS 350D AStar, provided by Aerospatiale Helicopter Corporation

3. Test Date: Wednesday, June 8, 1983.

4. Test Location: Dulles International Airport, Runway 30 over-run area.

5. Noise Data Measurement (recording), processing and analysis: Department of Transportation (DOT), Transportation Systems Center (TSC), Noise Measurement and Assessment Facility.

6. Noise Data Measurement (direct-read), processing and analysis: FAA, Noise Technology Branch (AEE-120).

7. Cockpit instrument photo documentation; photo-altitude determination system; documentary photographs: Department of Transportation, Photographic Services Laboratory.

8. Meteorological Data (fifteen minute observations): National Weather Service Office, Dulles International Airport.

9. Meteorological Data (radiosonde/rawinsonde weather balloon launches): National Weather Service Upper Air Station, Sterling Park, Virginia.

FIGURE 3.1
Flight Test and Noise Measurement Personnel In Action

10. Meteorological Data (on site observations): DOT-TSC.

11. Flight Path Guidance (portable visual approach slope indicator (VASI) and theodolite/verbal course corrections): FAA Technical Center, ACT-310.

12. Air Traffic Control: Dulles International Airport Air Traffic Control Tower.

13. Test site preparation; surveying, clearing underbrush, connecting electrical power, providing markers, painting signs, and other physical arrangements: Dulles International Airport Grounds and Maintenance, and Airways Facilities personnel.

Figure 3.1 is a photo collage of flight test and measurement personnel performing their tasks.

3.1 Measurement Facility - The noise measurement testing area was located adjacent to the approach end of Runway 12 at Dulles International Airport. (The approach end of Runway 12 is synonymous with Runway 30 over-run area.) The low ambient noise level, the availability of emergency equipment, and the security of the area all made this location desirable. Figure 3.2 provides a photograph of the Dulles terminal and of the test area.

The test area adjacent to the runway was nominally flat with a ground cover of short, clipped grass, approximately 1800 feet by 2200 feet, and bordered on north, south, and west by woods. There was minimum interference from the commercial and general aviation activity at the airport since Runway 12/30 was closed to normal traffic during the tests.

Figure 3.2

The Terminal and Air Traffic Control Tower
at Dulles International Airport

Approach to Runway 12 at Dulles Noise
Measurement Site for 1983 Helicopter Tests

The runways used for normal traffic, 1L and 1R, were approximately 2 and 3 miles east, respectively, of the test site.

The flight track centerline was located parallel to Runway 12/30 centered between the runway and the taxiway. The helicopter hover point for the static operations was located on the southwest corner of the approach end of Runway 12. Eight noise measurement sites were established in the grassy area adjacent to the Runway 12 approach ground track.

3.2 Microphone Locations - There were eight separate microphone sites located within the testing area, making up two measurement arrays. One array was used for the flight operations, the other for the static operations. A schematic of the test area is shown in Figure 3.3.

A. Flight Operations - The microphone array for flight operations consisted of two sideline sites, numbered 2 and 3 in Figure 3.3, and three centerline sites, numbered 5, 1, and 4, located directly below the flight path of the helicopter. Since site number 3, the north sideline site, was located in a lightly wooded area, it was offset 46 feet to the west to provide sufficient clearance from surrounding trees and bushes.

B. Static Operations - The microphone array for static operations consisted of sites 7H, 5H, 1H, 2, and 4H. These sites were situated around the helicopter hover point which was located on the southwest corner of the approach end of Runway 12. These site locations allowed for both hard and soft ground-to-ground propagation paths.

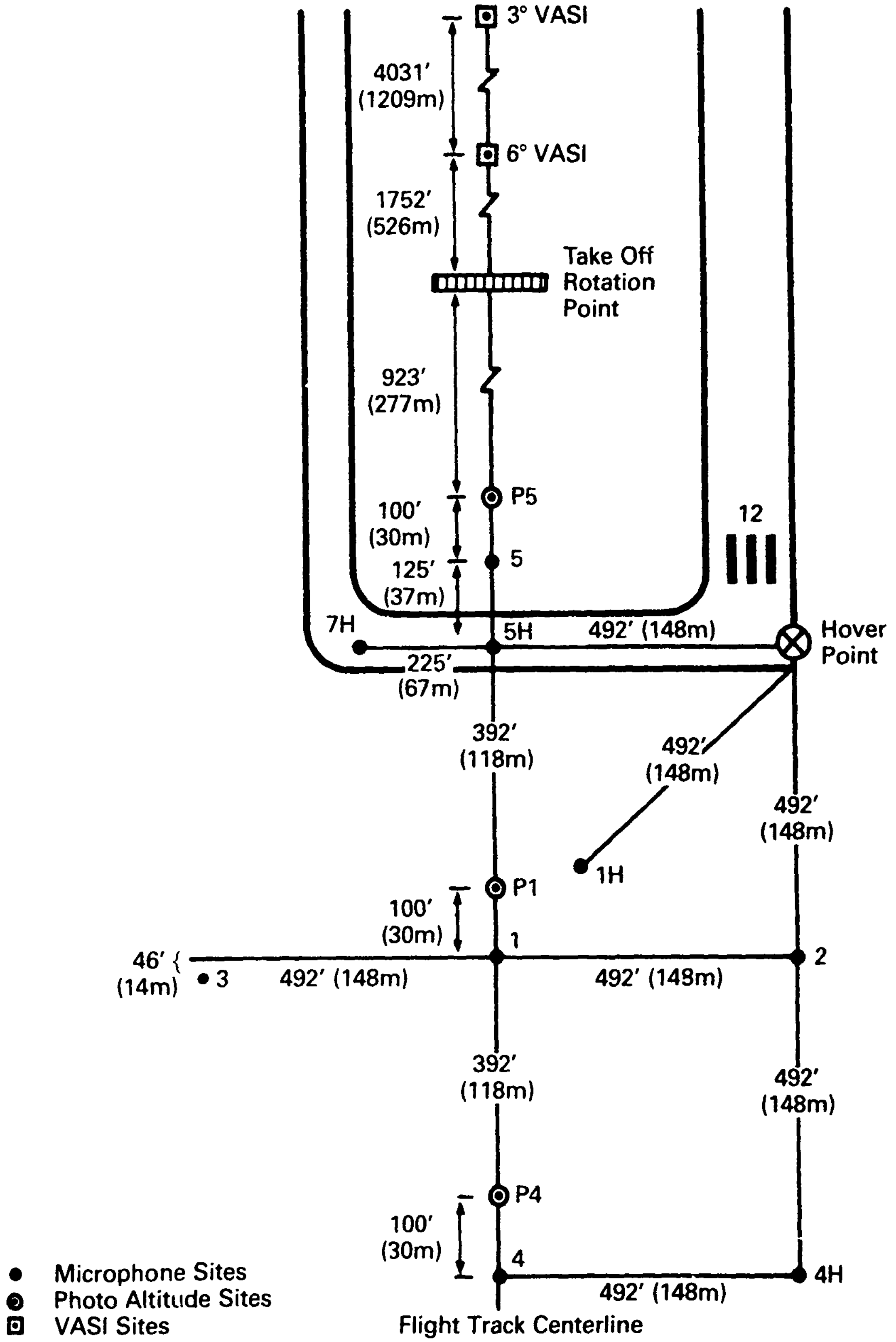
3.3 Flight Path Markers and Guidance System Locations - Visual cues in the form of squares of plywood painted bright yellow with a black "X" in the center were provided to define the takeoff rotation point. This point was located 1640 feet (500 m) from centerline center (CLC) microphone location. Four portable, battery-powered spotlights were deployed at various locations to assist pilots in maintaining the array centerline. To provide visual guidance during the approach portion of the test, a standard visual approach slope indicator (VASI) system was used. In addition to the visual guidance, the VASI crew also provided verbal guidance with the aid of a theodolite. Both methods assisted the helicopter pilot in adhering to the microphone array centerline and in maintaining the proper approach path. The locations of the VASI from CLC are shown in the following table.

Approach Angle (degrees)	Distance from CLC (feet)
12	1830
9	2456
6	3701
3	7423

Each of these locations provided a glidepath which crossed over the centerline center microphone location at an altitude of 394 feet. This test program involved approach operations utilizing 6 and 9 degree glide slopes.

FIGURE 3.3

Noise Measurement and Photo Site Schematic



NOTES: Broken Line Indicates not to Scale.
Metric Measurements to
Nearest Meter.

TEST PLANNING AND BACKGROUND

4.0 Test Planning/Background Activities - This section provides a brief discussion of important administrative and test planning activities.

4.1 Test Program Advance Briefings and Coordination - A pre-test briefing was conducted approximately one month prior to the test. The meeting was attended by all pilots participating in the test, along with FAA program managers, manufacturer test coordinators, and other key test participants from the Dulles Airport community. During this meeting, the airspace safety and communications protocol were rigorously defined and at the same time test participants were able to iron out logistical and procedural details. On the morning of the test, a final brief meeting was convened on the flight line to review safety rules and coordinate last-minute changes in the test schedule

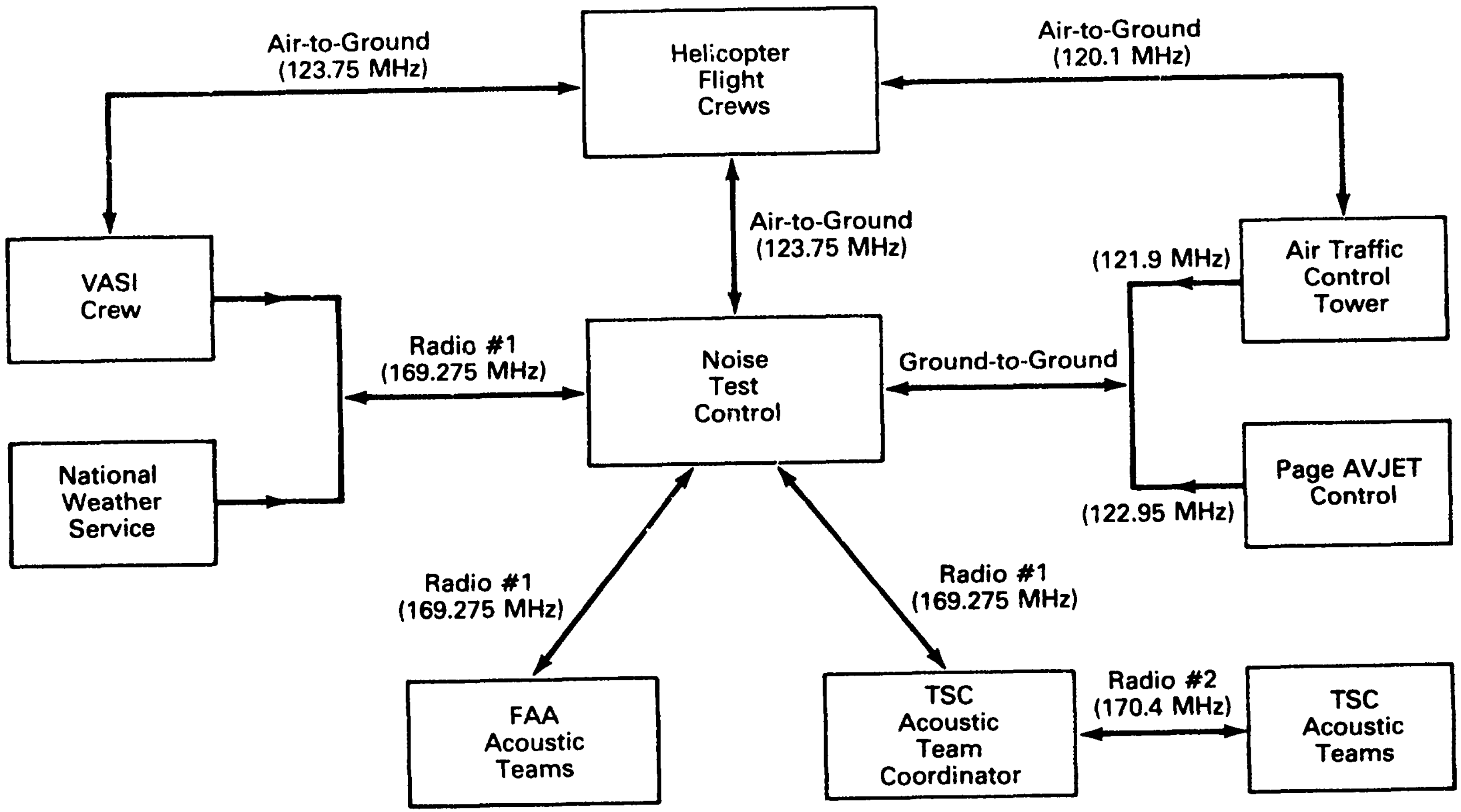
4.2 Communications Network - During the helicopter noise measurement test, an elaborate communications network was utilized to manage the various systems and crews. This network was headed by a central group which coordinated the testing using three two-way radio systems, designated as Radios 1-3.

Radio 1 was a walkie talkie system operating on 169.275 MHz, providing communications between the VASI, National Weather Service, FAA Acoustic Measurement crew, the TSC acoustic team coordinator, and the noise test coordinating team.

Radio 2 was a second walkie talkie system operating on 170.40 MHz, providing communications between the TSC acoustic team coordinator and the TSC acoustic measurement teams.

FIGURE 4.1

Helicopter Noise Test Communication Network Schematic



Radio 3, a multi-channel transceiver, was used as both an air-to-ground and ground-to-ground communications system. In air-to-ground mode it provided communications between VASI, helicopter flight crews, and noise test control on 123.175 MHz. In ground-to-ground mode it provided communications between the air traffic control tower (121.9 MHz), Page Avjet (the fuel source; 122.95 MHz), and noise test control. A schematic of this network is shown in Figure 4.1.

4.3 Local Media Notification - Noise test program managers working through the FAA Office of Public Affairs released an article to the local media explaining that helicopter noise tests were to be conducted at Dulles Airport on June 8, the test day commencing around dawn and extending through midday. The article described general test objectives, flight paths, and rationale behind the very early morning start time (low wind requirements). In the case of a farm located very close to the airport, a member of the program management team personally visited the residents and explained what was going to be involved in the test. As a consequence of these efforts (it is assumed), there were very few complaints about the test program.

4.4 Ambient Noise - One of the reasons that the Dulles Runway 30 over-run area was selected as the test site was the low ambient noise level in the area. Typically one observed an A-Weighted LEQ on the order of 45 dB, with dominant transient noise sources primarily from the avian and insect families. The primary offender was the Collinus Virginianus, commonly known as the bobwhite, quail, or partridge. The infrequent intrusive

sound pressure levels were on the order of 55 dB centered in the 2000 Hz one-third octave band. A drawing of the noisy offender and a narrow band analysis of the song may be found in figure 4.2.

As an additional measure for safety and for lessening ambient noise, a Notice to Airmen or NOTAM was issued advising aircraft of the noise test, and indicating that Runway 12/30 was closed for the duration of the test.

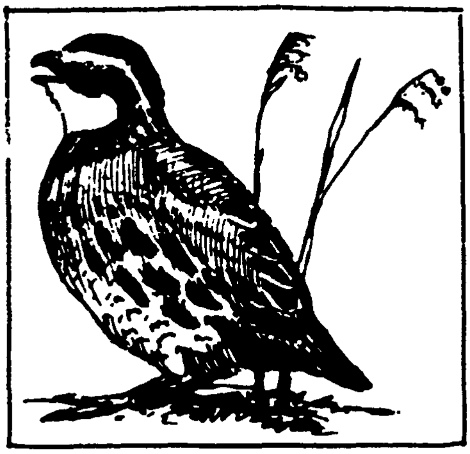
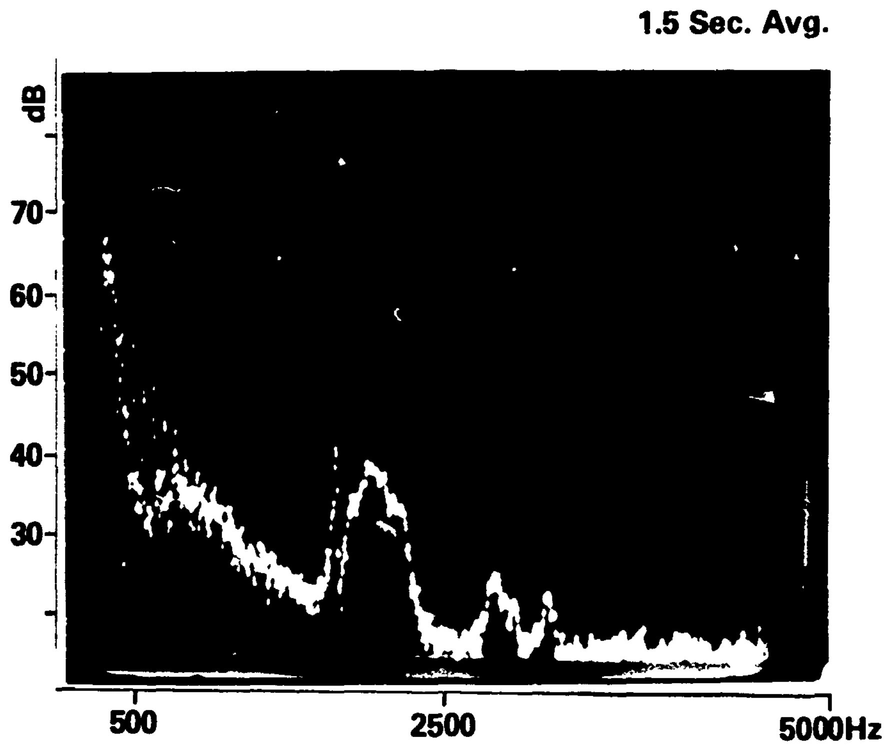


FIGURE 4.2



5.0 Data Acquisition and Guidance Systems - This section provides a detailed description of the test program data acquisition systems, with special attention given to documenting the operational accuracy of each system. In addition, discussion is provided (as needed) of field experiences which might be of help to others engaged in controlled helicopter noise measurements. In each case, the location of a given measurement system is described relative to the helicopter flight path.

5.1 Approach Guidance System - Approach guidance was provided to the pilot by means of a visual approach slope indicator (VASI) and through verbal commands from an observer using a ballon-tracking theodolite. (A picture of the theodolite is included in Figure 3.1, in Section 3.0.) The VASI and theodolite were positioned at the point where the approach path intercepted the ground.

The VASI system used in the test was a 3-light arrangement giving vertical displacement information within ± 0.5 degrees of the reference approach slope. The pilot observed a green light if the helicopter was within 0.5 degrees of the approach slope, red if below the approach slope, white if above. The VASI was adjusted and repositioned to provide a variety of approach angles. A picture of the VASI is included in Figure 3.1.

The theodolite system, used in conjunction with the VASI, also provided accurate approach guidance to the pilot. A brief time lag existed between the instant the theodolite observor perceived deviation, transmitted a

command, and the pilot made the correction; however, the theodolite crew was generally able to alert the pilot of approach path deviations (slope and lateral displacement) before the helicopter exceeded the limits of the one degree green light of the VASI. Thus, the helicopter only occasionally and temporarily deviated more than 0.5 degrees from the reference approach path.

Approach paths of 6 and 9 degrees were used during the test program. Table 5.1 summarizes the VASI beam width at each measurement location for a variety of the approach angles used in this test.

TABLE 5.1

REFERENCE HELICOPTER ALTITUDES FOR APPROACH TESTS
(all distances expressed in feet)

	MICROPHONE NO. 4	MICROPHONE NO. 1	MICROPHONE NO. 5
APPROACH ANGLE = 3°	A = 8010 B = 420 C = ±70	A = 7518 B = 394 C = ±66	A = 7026 B = 368 C = ±62
6°	A = 4241 B = 446 C = ±37	A = 3749 B = 394 C = ±33	A = 3257 B = 342 C = ±29
9°	A = 2980 B = 472 C = ±27	A = 2488 B = 394 C = ±22	A = 1362 B = 316 C = ±18

A = distance from VASI to microphone location

B = reference helicopter altitude

C = boundary of the 1 deg ee VASI glide slope "beam width".

5.2 Photo Altitude Determination Systems - The helicopter altitude over a given microphone was determined by the photographic technique described in the Society of Automotive Engineers report AIR-902 (ref. 1). This technique involves photographing an aircraft during a flyover event and proportionally scaling the resulting image with the known dimensions of the aircraft. The camera is initially calibrated by photographing a test object of known size and distance. Measuring the resulting image enables calculation of the effective focal length from the proportional relationship:

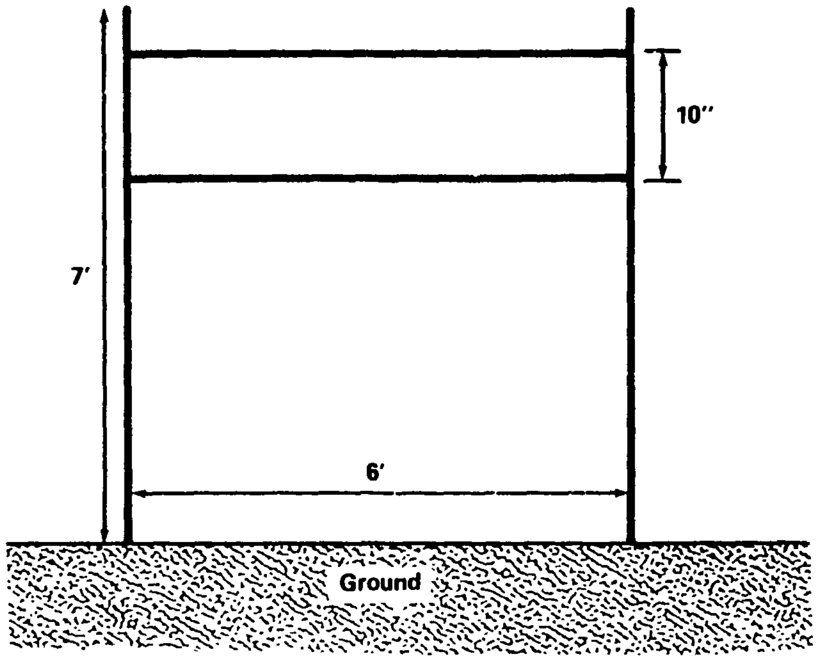
(image length)/(object length) = (effective focal length)/(object distance)

This relationship is used to calculate the slant distance from microphone to aircraft. Effective focal length is determined during camera calibration, object length is determined from the physical dimensions of the aircraft (typically the rotor diameter or fuselage) and the image size is measured on the photograph. These measurements lead to the calculation of object distance, or the slant distance from camera or microphone to aircraft. The concept applies similarly to measuring an image on a print, or measuring a projected image from a slide.

The SAE AIR-902 technique was implemented during the 1983 helicopter tests with three 35mm single lens reflex (SLR) cameras using slide film. A camera was positioned 100 feet from each of the centerline microphone locations. Lenses with different focal lengths, each individually calibrated, were used in photographing helicopters at differing altitudes in order to more fully "fill the frame" and reduce image measurement error.

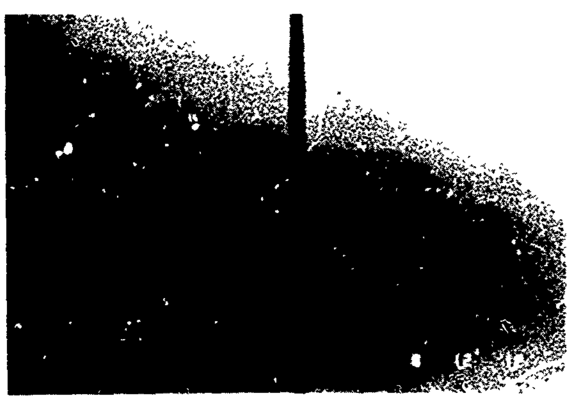
Figure 5.1

Photo Overhead Positioning System (Pop System)



Artist's Drawing of the Photo Overhead Positioning System (Figure is not to scale.)

Photographer using the POP system to photograph the helicopter.



Photographs of the AS 350D AStar, as taken by the photographer using the POP system.

The photoscaling technique assumes the aircraft is photographed directly overhead. Although SAE AIR-902 does present equations to account for deviations caused by photographing too soon or late, or by the aircraft deviating from the centerline, these corrections are not required when deviations are small. Typically, most of the deviations were acoustically insignificant. Consequently, corrections were not required for any of the 1983 test photos.

The photographer was aided in estimating when the helicopter was directly overhead by means of a photo-overhead positioning system (POPS) as illustrated in the figure and pictures in Figure 5.1 The POP system consisted of two parallel (to the ground) wires in a vertical plane orthogonal to the flight path. The photographer, lying beneath the POP system, initially positioned the camera to coincide with the vertical plane of the two guide wires. The photographer tracked the approaching helicopter in the viewfinder and tripped the shutter when the helicopter crossed the superimposed wires. This process of tracking the helicopter also minimized image blurring and the consequent elongation of the image of the fuselage.

A scale graduated in 1/32-inch increments was used to measure the projected image. This scaling resolution translated to an error in altitude of less than one percent. A potential error lies in the scaler's interpretation of the edge of the image. In an effort to quantify this error, a test group of ten individuals measured a selection of the fuzziest photographs from the helciopter tests. The resulting statistics revealed that 2/3 of the participants were within two percent of the mean altitude. SAE

AIR-902 indicates that the overall photoscaling technique, under even the most extreme conditions, rarely produces error exceeding 12 percent, which is equivalent to a maximum of 1 dB error in corrected sound level data. Actual accuracy varies from photo to photo; however, by using skilled photographers and exercising reasonable care in the measurements, the accuracy is good enough to ignore the resulting small error in altitude.

Tests were recently conducted in West Germany which compared this camera method with the more elaborate Kinotheodolite tracking method to discover which was best for determining overflight height and overground speed. Both methods were found to be reasonably accurate; thus, the simpler camera method remains appropriate for most test purposes (ref. 2).

5.3 Cockpit Photo Data - During each flight operation of the test program, cockpit instrument panel photographs were taken with a 35mm SLR camera, with an 85mm lens, and high speed slide film. These pictures served as verification of the helicopter's speed, altitude, and torque at a particular point during a test event. The photos were intended to be taken when the aircraft was directly over the centerline-center microphone site #1 (see Figure 3.3). Although the photos were not always taken at precisely that point, the pictures do represent a typical moment during the test event. The word typical is important because the snapshot freezes instrument readings at one moment in time, while actually the readings are constantly changing by a small amount because of instrument fluctuation and pilot input. Thus, fluctuations above or below reference conditions are to be anticipated. A reproduction of a typical cockpit photo is shown in Figure 5.2. When slides were projected onto a screen,

it was possible to read and record the instrument readings with reasonable accuracy. This data acquisition system was augmented by the presence of an experienced cockpit obersver who provided additional documentation of operational para-eters.

For future tests, the use of a video tape system is being considered to acquire a continuous record of cockpit parameters during each data run. Preliminary FAA studies (April 1984) indicate that this technique can be successful using off the shelf equipment.

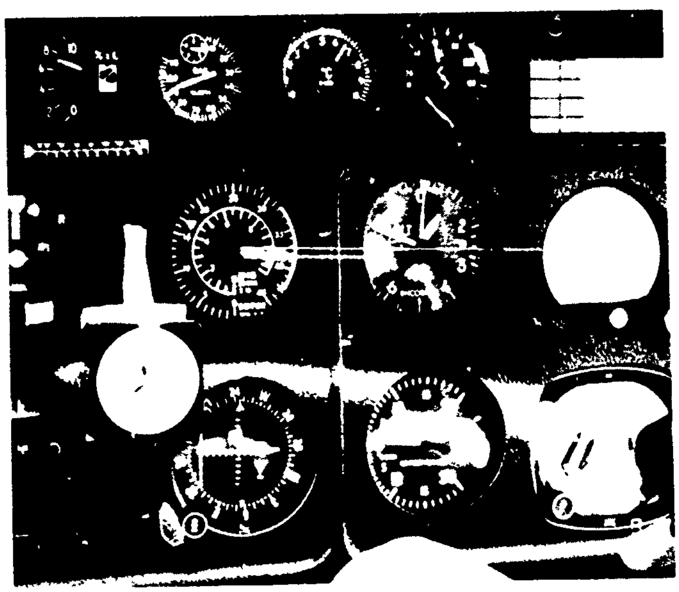


FIGURE 5.2

5.4 Upper Air Meteorological Data Acquisition/NWS: Sterling, VA - The National Weather Service (NWS) at Sterling, Virginia provided upper air meteorological data obtained from balloon-borne radiosondes. These data consisted of pressure, temperature, relative humidity, wind direction, and

speed at 100' intervals from ground level through the highest test altitude. The balloons were launched approximately 2 miles north of the measurement array. To slow the ascent rate of the balloon, an inverted parachute was attached to the end of the flight train. The VIZ Accu-Lok (manufacturer) radiosonde employed in these tests consisted of sensors which sampled the ambient temperature, relative humidity, and pressure of the air. Each radiosonde was individually calibrated by the manufacturer. The sensors were coupled to a radio transmitter which emitted an RF signal of 1680 MHz sequentially pulse-modulated at rates corresponding to the values of sampled meteorological parameters. These signals were received by the ground-based tracking system and converted into a continuous trace on a strip chart recorder. The levels were then extracted manually and entered into a minicomputer where calculations were performed. Wind speed and direction were determined from changes in position and direction of the "flight train" as detected by the radiosonde tracking system. Figure 5.3 shows technicians preparing to launch a radiosonde.

FIGURE 5.3

The manufacturer's specifications for accuracy are:

Pressure = ± 4 mb up to 250 mb

Temperature = $\pm 0.5°C$, over a range of +30°C to -30°C

Humidity = $\pm 5\%$ over a range of $\pm 25°C$ to 5°C

The National Weather Service has determined the "operational accuracy" of a radiosonde (as documented in an unpublished report entitled "Standard for Weather Bureau Field Programs", 1-1-67) to be as follows:

Pressure = ± 2 mb, over a range of 1050 - 5 mb

Temperature = $\pm 1°C$, over a range of +50°C to -70°C

Humidity = $\pm 5\%$ over a range of +40°C to -40°C

The temperature and pressure data are considered accurate enough for general documentary purposes. The relative humidity data are the least reliable. The radiosonde reports lower than actual humidities when the air is near saturation. These inaccuracies are attributable to the slow response time of the humidity sensor to sudden changes. (Ref. 3).

For future testing, the use of a SODAR (acoustical sounding) system is being considered. The SODAR is a measurement system capable of defining the micro-wind structure, making the influences of wind speed, direction and gradient easier to identify and to assess in real time (Ref. 4).

5.5 Surface Meteorological Data Acquisition/NWS: Dulles Airport - The National Weather Service Station at Dulles provided temperature, windspeed, and wind direction on the test day. Readings were noted every 15 minutes. These data are presented in Appendix H. The temperature transducers were located approximately 2.5 miles east of the test site at

a height of 6 feet (1.8 m) above the ground, the wind instruments were at a height of 30 feet (10 m) above ground level. The dry bulb thermometer and dew point transducer were contained in the Bristol (manufacturer) HO-61 system operating with ± one degree accuracy. The windspeed and direction were measured with the Electric Speed Indicator (manufacturer) F420C System, operating with an accuracy of 1 knot and ±5°.

On-site meterological data were also obtained by TSC personnel using a Climatronics (manufacturer) model EWS weather system. The anemometer and temperature sensor were located 10 feet above ground level at noise site 4. These data are presented in Appendix I. The following table:

(Table 5.2) identifies the accuracy of the individual components of the EWS system.

TABLE 5.2

Sensor	Accuracy	Range	Time Constant
Windspeed	±.025 mph or 1.5%	0-100 mph	5 sec
Wind Direction	±1.5%	0-360°	15 sec
Relative Humidity	±2% 0-100% RH	0-100% RH	10 sec
Temperature	±1.0°F	-40 to +120°F	10 sec

After "detection" (sensing), the meteorological data are recorded on a Rustrak (manufacturer) paperchart recorder. The following table (Table 5.3) identifies the range and resolutions associated with the recording of each parameter.

TABLE 5.3

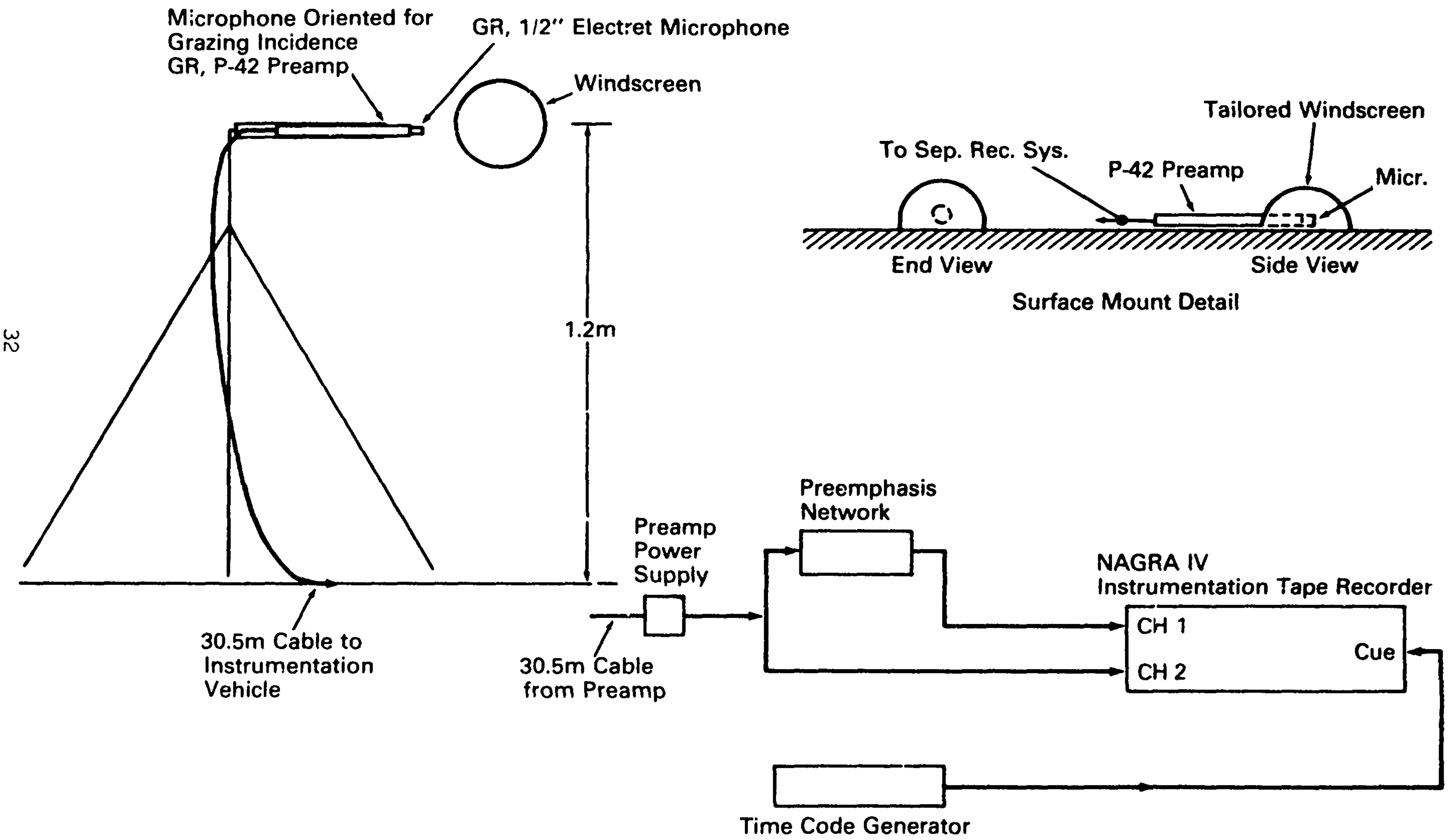
Sensor	Range	Chart Resolution
Windspeed	0-25 TSC mod 0-50 mph	±0.5 mph
Wind Direction		±5°
Relative Humidity	0-100% RH	±2% RH
Temperature	-40° to 120°F	±1°F

5.6.0 Noise Data Acquisition Sytems/System Deployment - This section provides a detailed description of the acoustical measurement systems employed in the test program along with the deployment plan utilized in each phase of testing.

5.6.1 Description of TSC Magnetic Recording Systems - TSC personnel deployed Nagra two-channel direct-mode tape recorders. Noise data were recorded with essentially flat frequency response on one channel. The same input data were weighted and amplified using a high frequency pre-emphasis filter and were recorded on the second channel. The pre-emphasis network rolled off those frequencies below 10,000 Hz at 20 dB per decade. The use of pre-emphasis was necessary in order to boost the high frequency portion of the acoustical signal (such as a helicopter spectrum) characterized by large level differences (30 to 60 dB) between the high and low frequencies. Recording gains were adjusted so that the best possible signal-to-noise ratio would be achieved while allowing enough "head room" to comply with applicable distortion avoidance requirements.

FIGURE 5.4

Acoustical Measurement Instrumentation



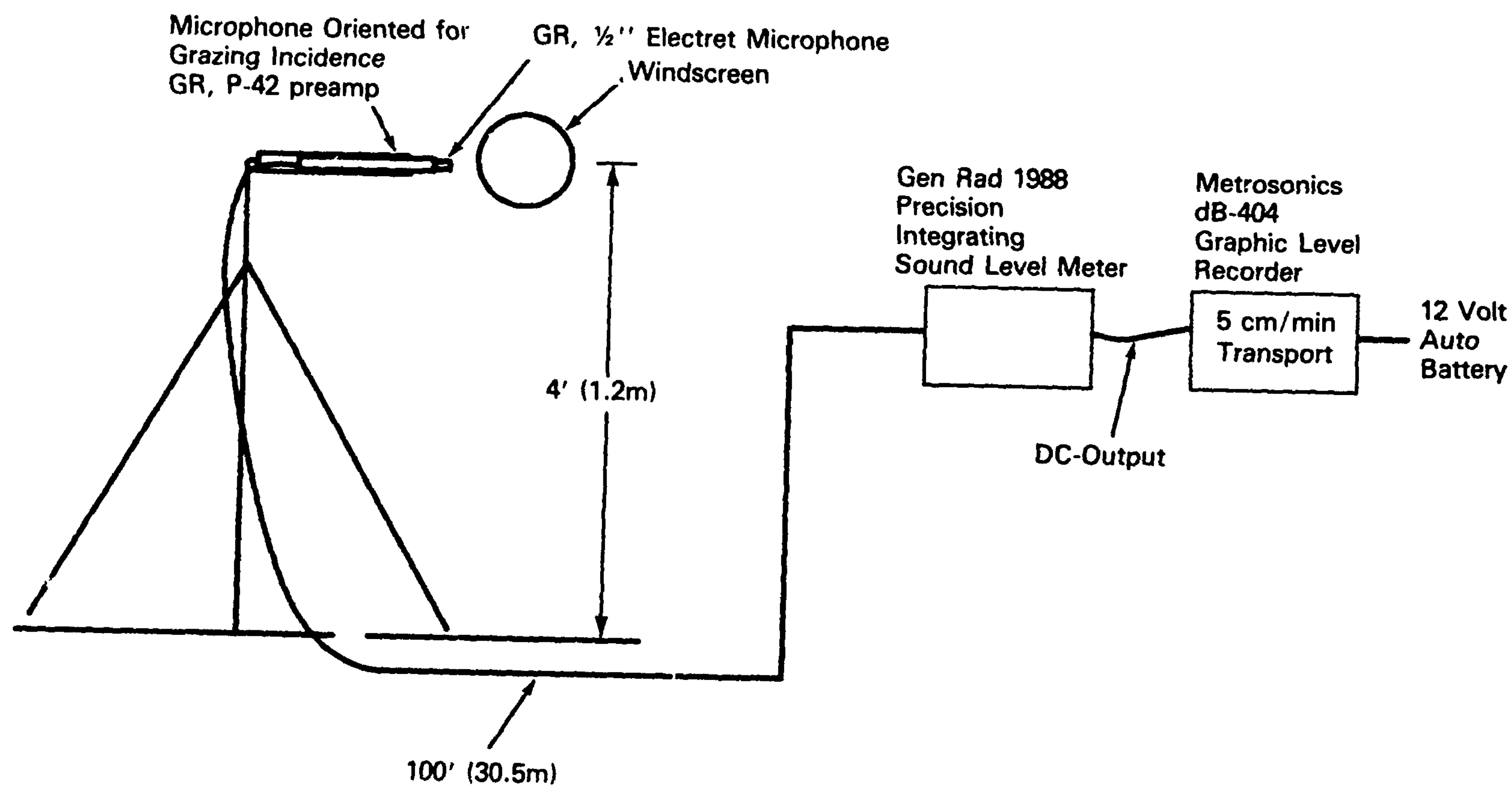
IRIG-B time code synchronized with the tracking time base was recorded on the cue channel of each system. The typical measurement system consisted of a General Radio 1/2 inch electret microphone oriented for grazing incidence driving a General Radio P-42 preamp and mounted at a height of four feet (1.2 meters). A 100-foot (30.5 meters) cable was used between the tripod and the instrumentation vehicle located at the perimeter of the test circle. A schematic of the acoustical instrumentation is shown in Figure 5.4.

Figure 5.4 also shows the cutaway windscreen mounting for the ground microphone. This configuration places the lower edge of the microphone diaphram approximately one-half inch from the plywood (4 ft by 4 ft) surface. The ground microphone was located off center in order to avoid natural mode resonant vibration of the plywood square.

5.6.2 <u>FAA Direct Read Measurement Systems</u> - In addition to the recording systems deployed by TSC, four direct read, Type-1 noise measurement systems were deployed at selected sites. Each noise measurement site consisted of an identical microphone-preamplifier system comprised of a General Radio 1/2-inch electret microphone (1962-9610) driving a General Radio P-42 preamplifier mounted 4 feet (1.2m) above the ground and oriented for grazing incidence. Each microphone was covered with a 3-inch windscreen.

FIGURE 5.5

Acoustical Measurement Instrumentation



Direct Read Noise Measurement System

Three of the direct read systems utilized a 100-foot cable connecting the microphone system with a General Radio 1988 Precision Integrating Sound Level Meter (PISLM). In each case, the slow response A-weighted sound level was output to a graphic level recorder (GLR). The GLRs operated at a paper transport speed of 5 centimeters per minute (300 cm/hr). These systems collected single event data consisting of maximum A-weighted Sound Level (AL), Sound Exposure Level (SEL), integration time (T), and equivalent sound level (LEQ).

The fourth microphone system was connected to a General Radio 1981B Sound Level Meter. This meter, used at site 7H for static operations only, provided A-weighted Sound Level values which were processed using a micro sampling technique to determine LEQ.

All instruments were calibrated at the beginning and end of each test day and approximately every hour in between. A schematic drawing of the basic direct read system is shown in Figure 5.5.

5.6.3 Deployment of Acoustical Measurement Instrumentation - This section describes the deployment of the magnetic tape recording and direct read noise measurement systems.

During the testing, TSC deployed six magnetic tape recording systems. During the flight operations, four of these recording system were located at the three centerline sites: one system at site 4, one at site 5, and two at centerline center with the microphone of one of those systems at 4

feet above ground, the microphone of the other at ground level. The two remaining recording systems were located at the two sidelines sites. The FAA deployed three direct read systems at the three centerline sites during the flight operations. Figure 5.6 provides a schematic drawing of the equipment deployment for the flight operations.

In the case of static operations, only four of the six recorder systems were used. The recorder system with the 4-foot microphone at site 1 moved to site 1H. The recorders at sites 4 and 5 moved to 4H and 5H respectively. The recorder at site 2, the south sideline site, was also used. The three direct read systems were moved from the centerline sites to sites 5H, 2, and 4H. The fourth direct read system was employed at site 7H. Figure 5.7 provides a schematic diagram of the equipment deployment for the static operations.

FIGURE 5.6

Microphone and Acoustical Measurement Instrument Deployment Flight Operations

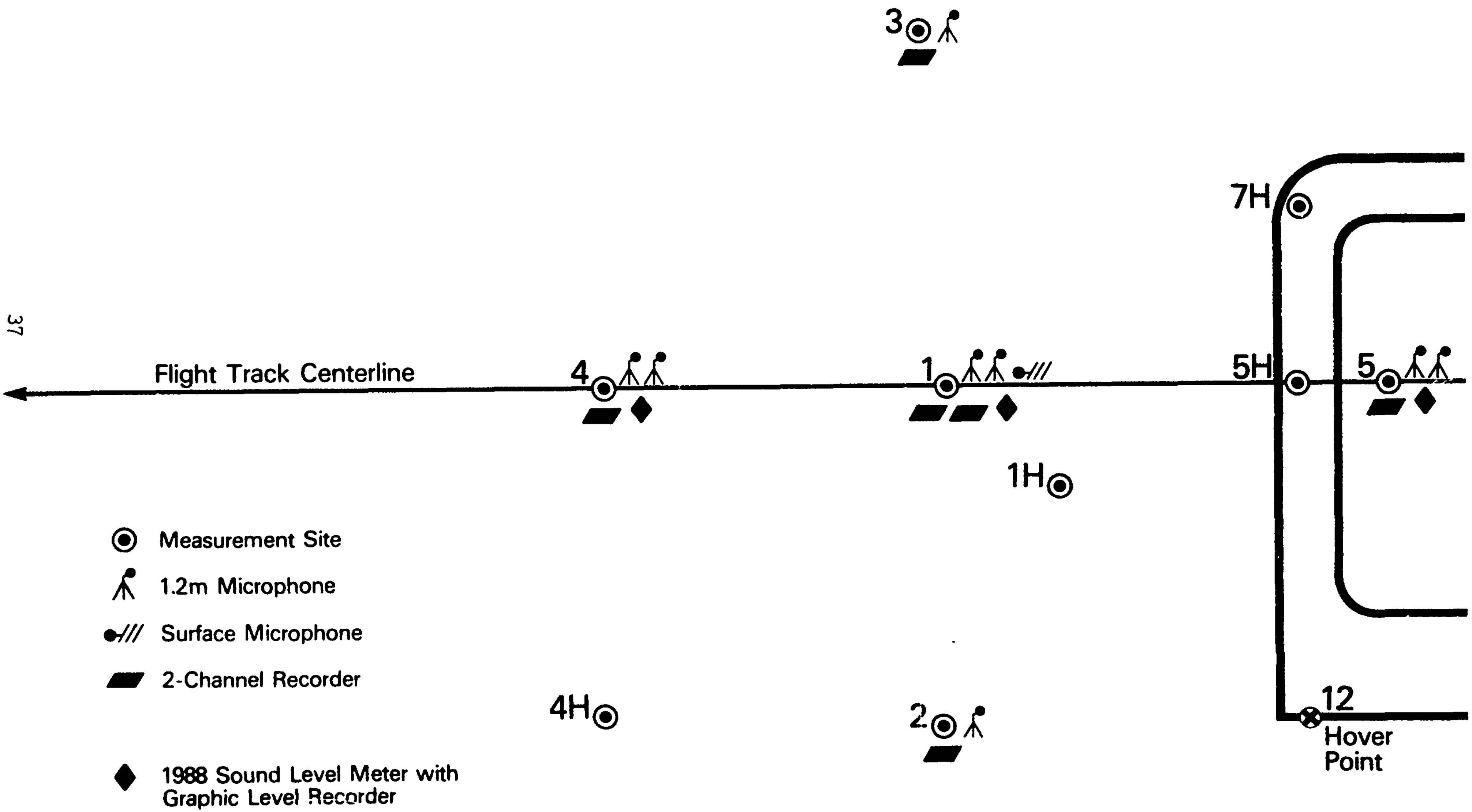
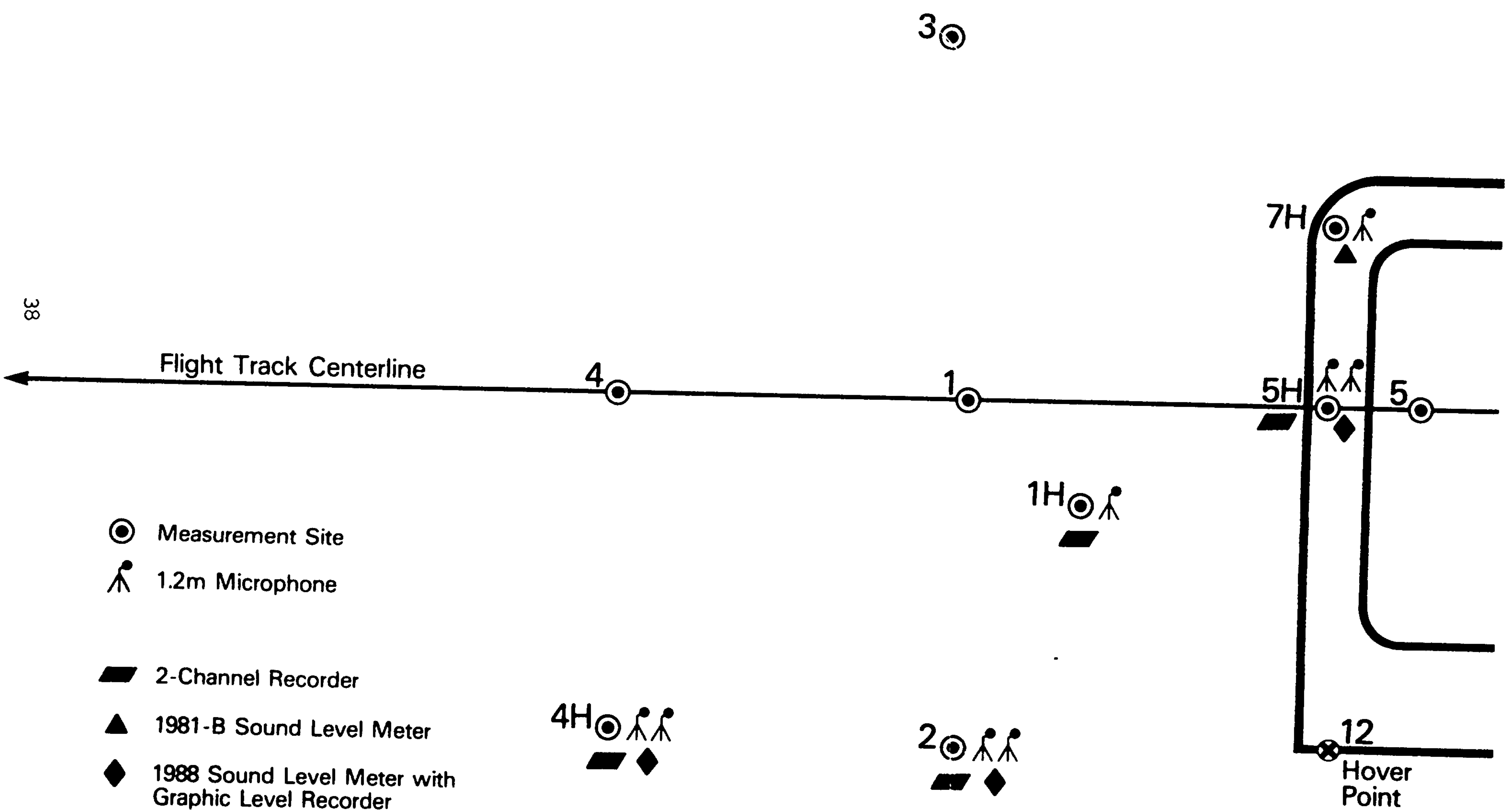


FIGURE 5.7
Microphone and Acoustical Measurement Instrument Deployment Static Operations



ACOUSTICAL DATA REDUCTION

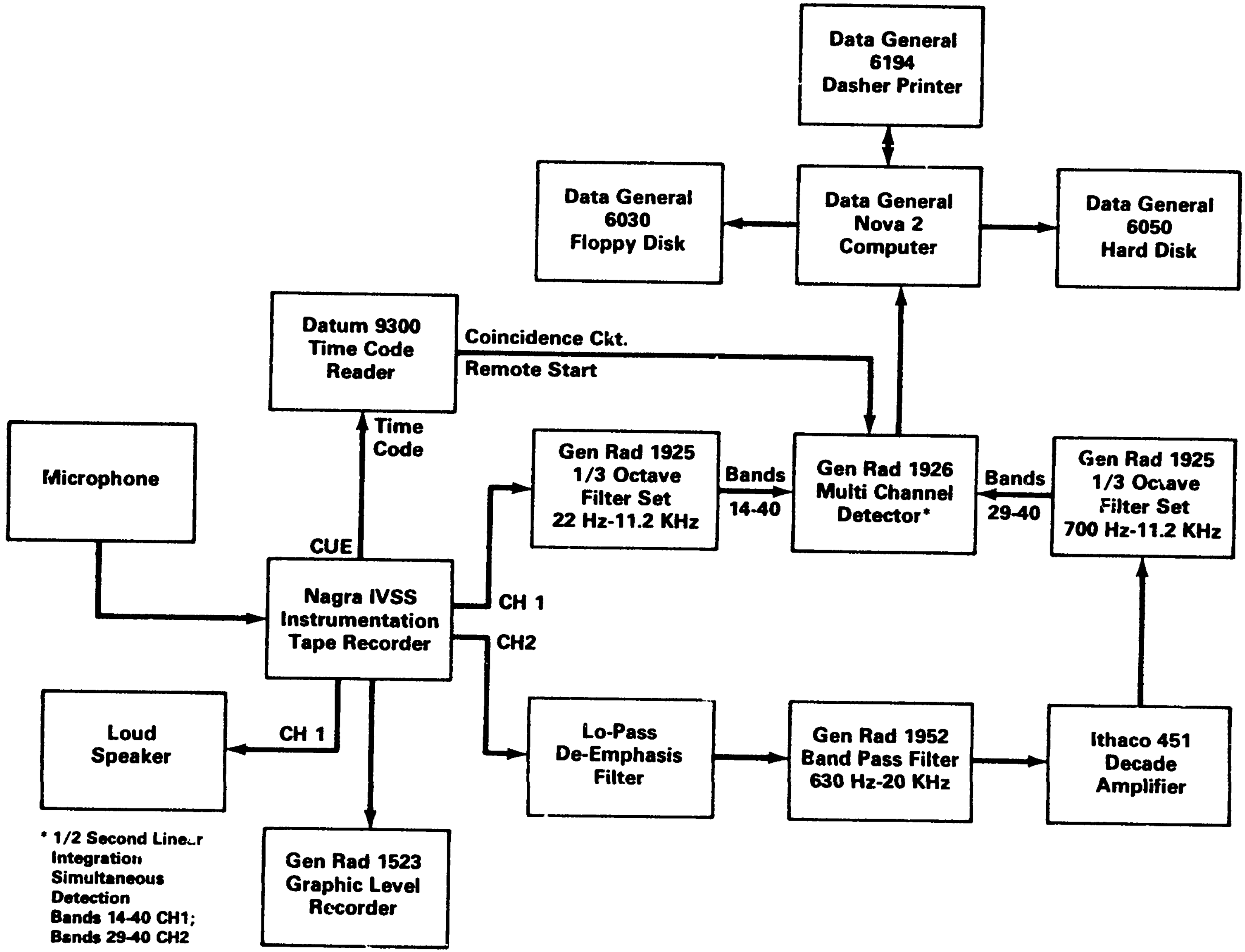
6.0 Acoustical Data Reduction - This section describes the treatment of tape recorded and direct read acoustical data from the point of acquisition to point of entry into the data tables shown in the appendices of this document.

6.1 TSC Magnetic Recording Data Reduction - The analog magnetic tape recordings analyzed at the TSC facility in Cambridge, Massachusetts were fed into magnetic disc storage after filtering and digitizing using the GenRad 1921 one-third octave real-time analyzer. Figure 6.1 is a picture of the TSC facility; Figure 6.2 provides a flow chart of the date collection, reduction and output process accomplished by TSC personnel. Recording system frequency response adjustments were applied, assuring overall linearity of the recording and reduction system. The stored 24, one-third octave sound pressure levels (SPLs) for contiguous one-half second integration periods making up each event comprise the base of "raw data." Data reduction followed the basic procedures defined in Federal Aviation Regulation (FAR) Part 36 (Ref. 3). The following sections describe the steps involved in arriving at final sound level values.

FIGURE 6.1

FIGURE 6.2

Acoustical Data Reduction/Instrumentation



6.1.1 Ambient Noise - The ambient noise is considered to consist of both the acoustical background noise and the electrical noise of the measurement system. For each event, the ambient level was taken as the five to ten-second time averaged one-third octave band taken immediately prior to the event. The ambient noise was used to correct the measured raw spectral data by subtracting the ambient level from the measured noise levels on an energy basis. This subtraction yielded the corrected noise level of the aircraft. The following execptions are noted:

1. At one-third octave frequencies of 630 Hz and below, if the measured level was within 3 dB of the ambient level, the measured level was corrected by being set equal to the ambient. If the measured level was less than the ambient level, the measured level was not corrected.

2. At one-third octave frequencies above 630 Hz, if the measured level was within 3 dB or less of the ambient, the level was identified as "masked."

6.1.2 Spectral Shaping - The raw spectral data, corrected for ambient noise, were adjusted by sloping the spectrum shape at -2 dB per one-third octave for those bands (above 1.25 kHz) where the signal to noise ratio was less than 3 dB, i.e., "masked" bands. This procedure was applied in cases involving no more than 9 "masked" one-third octave bands. The shaping of the spectrum over this 9-band range was conducted to minimize EPNL data loss. This spectral shaping methodology deviates from FAR-36 procedures in that the extrapolation includes four more bands than normally allowed.

6.1.3 Analysis System Time Constant/Slow Response - The corrected raw spectral data (contiguous linear 1/2 second records of data) were

processed using a sliding window or weighted running logarithmic averaging procedure to achieve the "slow" dynamic response equivalent to the "slow response" characteristic of sound level meters as required under the provisions of FAR-36. The following relationship using four consecutive data records was used:

$$L_i = 10 \text{ Log } [0.13(10.^{0.1L_{i-3}})+0.21(10.^{0.1L_{i-2}})+0.27(10.^{0.1L_{i-1}})+0.39(10.^{0.1L_i})]$$

where L_i is the one-third octave band sound pressure level for the ith one-half second record number.

6.1.4 Bandsharing of Tones - All calculations of PNLTM included testing for the presence of band sharing and adjustment in accordance with the procedures defined in FAR-36, Appendix B, Section B 36.2.3.3, (Ref. 6).

6.1.5 Tone Corrections - Tone corrections were computed using the helicopter acoustical spectrum from 24 Hz to 11,200 Hz, (bands 14 through 40). Tone correction values were computed for bands 17 through 40, the same set of bands used in computing the EPNL and PNLT. The initiation of the tone correction procedure at a lower frequency reflects recognition of the strong low frequency tonal content of helicopter noise. This procedure is in accordance with the requirements of ICAO Annex 16, Appendix 4, paragraph 4.3. (Ref. 7)

6.1.6 Other Metrics - In addition to the EPNL/PNLT family of metrics and the SEL/AL family, the overall sound pressure level and 10-dB down duration times are presented as part of the "As Measured" data set in Appendix A. Two factors relating to the event time history (distance duration and speed corrections, discussed in a later section) are also presented.

6.1.7 Spectral Data/Static Tests - In the case of static operations, thirty-two seconds of corrected raw spectral data (64 contiguous 1/2 second data records) were energy averaged to produce the data tabulated in Appendix C. The spectral data presented is "as measured" at the emission angles shown in Figure 6.3, established relative to each microphone location. Also included in the tables are the 360 degree (eight emission angles) average levels, calculated by both arithmetic and energy averaging.

Note that "masked" levels (see Section 6.1.1) are replaced in the tables of Appendix C with a dash (-). The indexes shown, however, were calculated with a shaped spectra as per Section 6.1.2.

FIGURE 6.3

Acoustical Emission Angle Convention

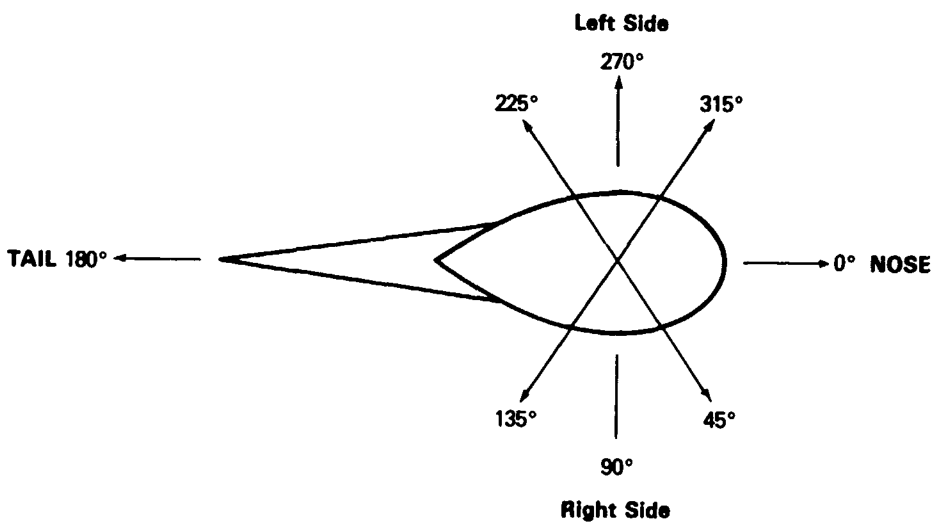
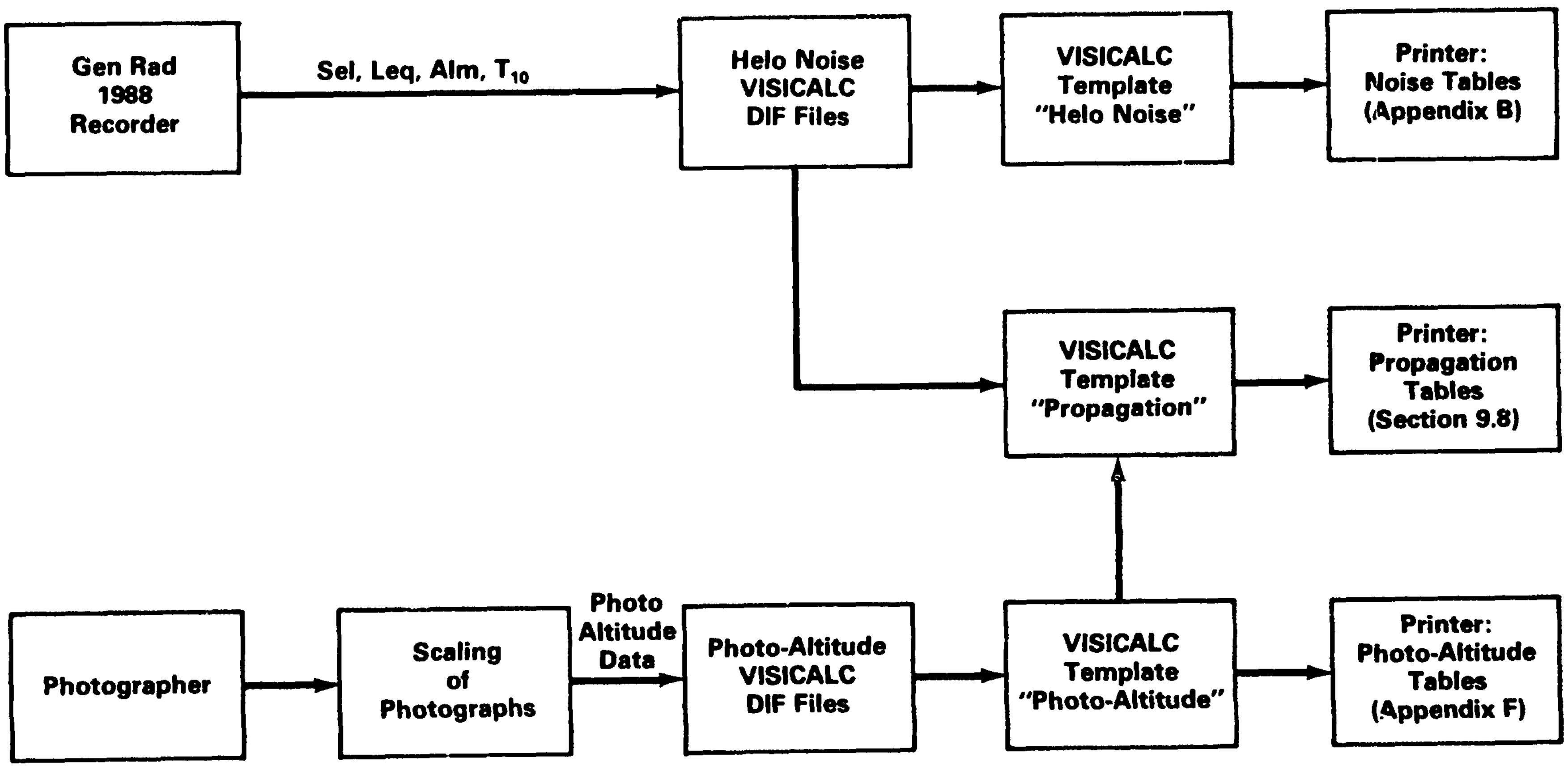


FIGURE 6.4

Direct Read Data Reduction



6.2 FAA Direct Read Data Reduction - Figure 6.4 provides a flow diagram of the data collection, reduction and output process effected by FAA personnel. FAA direct read data was reduced using the Apple IIe microcomputer and the VISICALC® software package. VISICALC® is an electronic worksheet composed of 256 x 256 rows and columns which can support mathematical manipulation of the data placed anywhere on the worksheet. This form of computer software lends itself to a variety of data analyses, by means of constructing templates (worksheets constructed for specific purposes). Data files can be constructed to contain a variety of information such as noise data and position data using a file format called DIF (data interchange format).

Data analysis can be performed by loading DIF files onto analysis templates. The output or results can be displayed in a format suitable for inclusion in reports or presentations. Data tables generated using these techniques are contained in Appendices B and D, and are discussed in Section 9.0.

6.2.1 Aircraft Position and Trajectory - A VISICALC® DIF file was created to contain the photo altitude data for each event of each test series for the test conducted. These data were input into a VISICALC® template designed to perform a 3-point regression through the photo altitude data from which estimates of aircraft altitudes could be determined for each microphone location.

6.2.2 Direct Read Noise Data - Another template was designed to take two VISICALC® DIF files as input. The first contained the "as measured" noise levels SEL and dBA obtained from the FAA direct read systems and the 10-dB duration time obtained from the graphic level recorder strips, for each of the three microphone sites.

The second consisted of the estimates of aircraft altitude over three microphone sites. Calculations using the two input files determined two figures of merit related to the event duration influences on the SEL energy dose metric. This analysis is described in Section 9.4. All of the available template output data are presented in Appendix B.

TEST SERIES DESCRIPTION

7.0 Test Series Description - The noise-flight test operations schedule for the Aerospatiale AStar consisted of two major parts.

The first part or core test program included the ICAO certification test operations (takeoff, approach, and level flyover) supplemented by level flyovers at various altitudes (at a constant airspeed) and at various airspeeds (at a constant altitude). In addition to the ICAO takeoff operation, a second, direct climb takeoff flight series was included. An alternative approach operation was also included, utilizing a nine degree approach angle to compare results with the six degree ICAO approach data.

The second part of the test program consisted of static operations designed to assess helicopter directivity patterns and examine ground-to-ground propagation.

The information presented in Table 7.1 describes the Aerospatiale AStar test schedule by test series, each test series representing a group of similar events. Each noise event is identified by a letter prefix, corresponding to the appropriate test series, followed by a number which represents the numerical sequence of event (i.e., A1, A2, A3, A4, B5, B6,...etc.). In some cases the actual order of test series may not follow alphabetically, as a D1, D2, D3, D4, E5, E6, E8, H9, H10, H11,... etc.). In the case of static operations the individual events are reported by the acoustical emission angle referenced to each individual microphone location (i.e., J120, J165, J210, J255, J300, J345, J030, J75). In Table 7.1, the test target operational parameters for each series are specified along with approximate start and stop times. These times can be used to

reference corresponding meteorological data in Appendix G. Timing of fuel breaks are also identified so that the reader can estimate changes in helicopter weight with fuel burn-off. Actual operational parameters and position information for specific events are specified in the appendices of this document.

The "standard takeoff" operation, elected by the manufacturer, consisted of a direct climbout from a 5-foot hover, using the best angle of climb. The reader is referred to Appendices E and F for appropriate cockpit instrument and trajectory information necessary to fully characterize this operation.

Figures 7.1, 7.2 and 7.3 present the test flight configuration for the takeoff, approach and level flyover operations. A schematic of the actual flight tracks is available in Figure 3.3.

TABLE 7.1

TEST SUMMARY

ASTAR

TEST SERIES AND RUN NO.	DESCRIPTION OF SERIES	START TIME	FINISH TIME
I	Hover in ground effect	8:05 am	8:24 am
J(A)	Static/flight idle	8:26 am	8:50 am
J(B)	Static/ground idle	8:26 am	8:50 am
F/F1-F9	6 deg approach, 63 mph	9:18 am	9:51 am
	FUEL BREAK		
E/E10-E17	ICAO takeoff, 63 mph	10:26 am	10:42 am
H/H18-H21	9 deg approach, 75 mph	10:47 am	10:56 am
A/A22-A27	LFO, 500 ft./0.9 VH	11:03 am	11:13 am
B/B28-B31	LFO, 500 ft./0.8 VH	11:20 am	11:30 am
C/C33-C36	LFO, 500 ft./0.7 VH	11:35 am	11:42 am
D/D37-D40	LFO, 1000 ft./0.9 VH	11:45 am	11:51 am
N/N41-N44	LFO, 500 ft./143 mph	11:54 am	11:59 am
M/M45-M48	LFO, 500 ft./86 mph	12:02 pm	12:08 pm
G/G49-G54	Takeoff	12:13 pm	12:30 pm

Note: Test series are listed in the order of actual testing. Running order changes were made as dictated by environmental conditions.

FIGURE 7.1

Helicopter Takeoff Noise Tests

The take-off flight path shall be established as follows:

a) the helicopter shall be established in level flight at the best rate of climb speed, V_y, $\pm$ 3 knots, of the maximum speed of the curve contignous to the ordinated of the limiting height-speed envelope + 3 knots ($\pm$3 knots), whichever is greater, and, at a height of 20 m (66 ft) above the ground until a point 500 m (1,640 ft) before the flight path reference point is reached;

b) upon reaching the point specified in a) above, the power shall be increased to maximum take-off power and a steady climb initiated and maintained over the noise measurement time period;

c) airspeed established in a) above shall be maintained throughout the take-off reference procedure;

d) the steady climb shall be made with the rotor speed stabilized at the maximum rpm for power-on operations

e) a constant take-off configuration selected by the applicant shall be maintained throughout the take-off reference procedure except that the landing gear may be retracted; and

f) the weight of the helicopter shall be the maximum take-off weight.

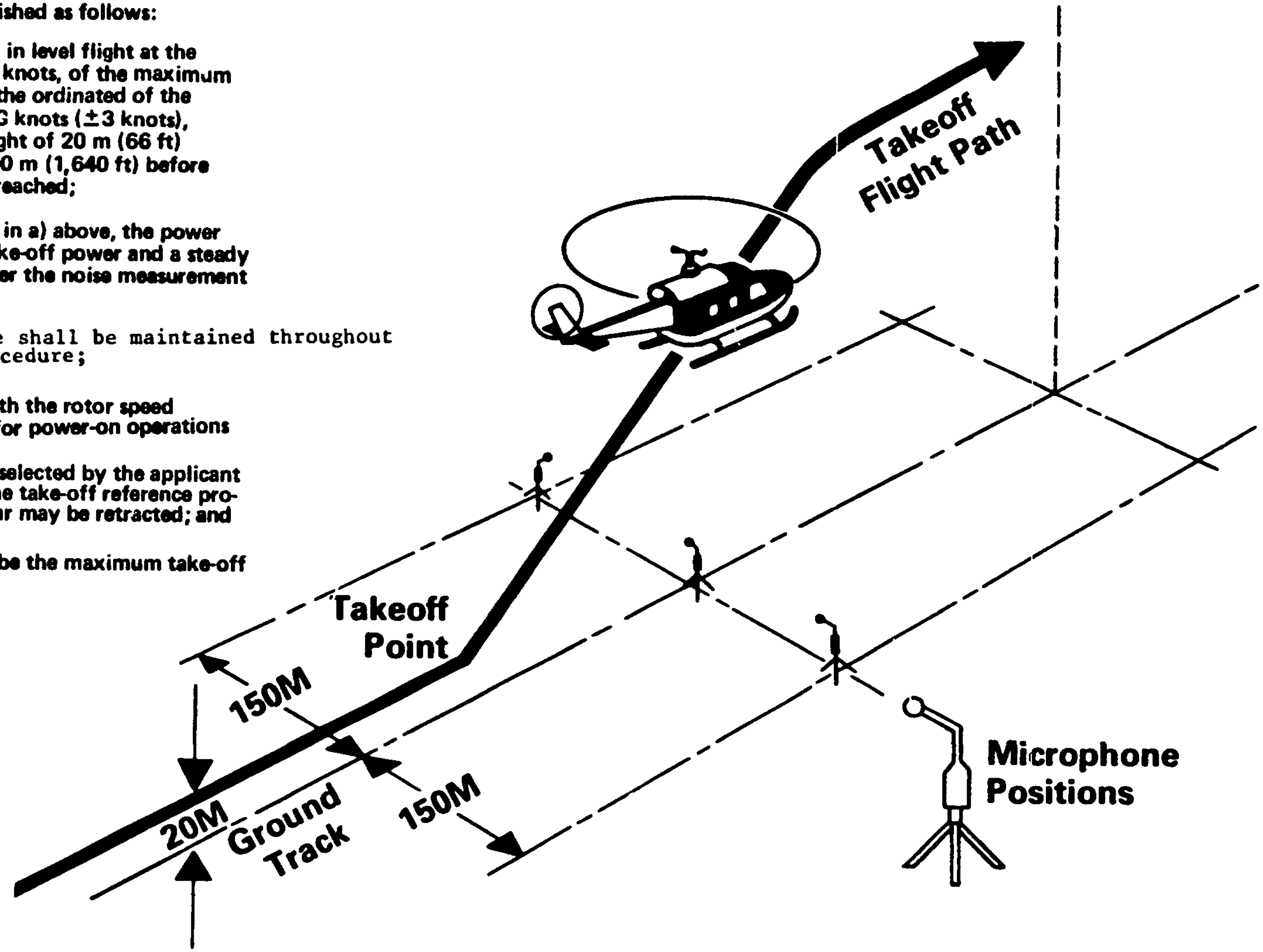


FIGURE 7.2

Helicopter Approach Noise Tests

The approach procedure shall be established as follows:

a) the helicopter shall be stabilized and following a 6.0° approach path;

b) the approach shall be made at a stabilized airspeed equal to the best rate of climb speed V_y, ± 3 knots, or the maximum speed of the curve contiguous to the ordinate of the limiting height-speed envelope + 3 knots (± 3 knots), whichever is the greater, with power stabilized during the approach and over the flight path reference point, and continued to 50 feet above ground level

c) the approach shall be made with the rotor speed stabilized at the maximum rpm for power-on operations.

d) the constant approach configuration used in airworthiness certification tests, with the landing gear extended, shall be maintained throughout the approach reference procedure; and

e) the weight of the helicopter shall be the maximum landing weight

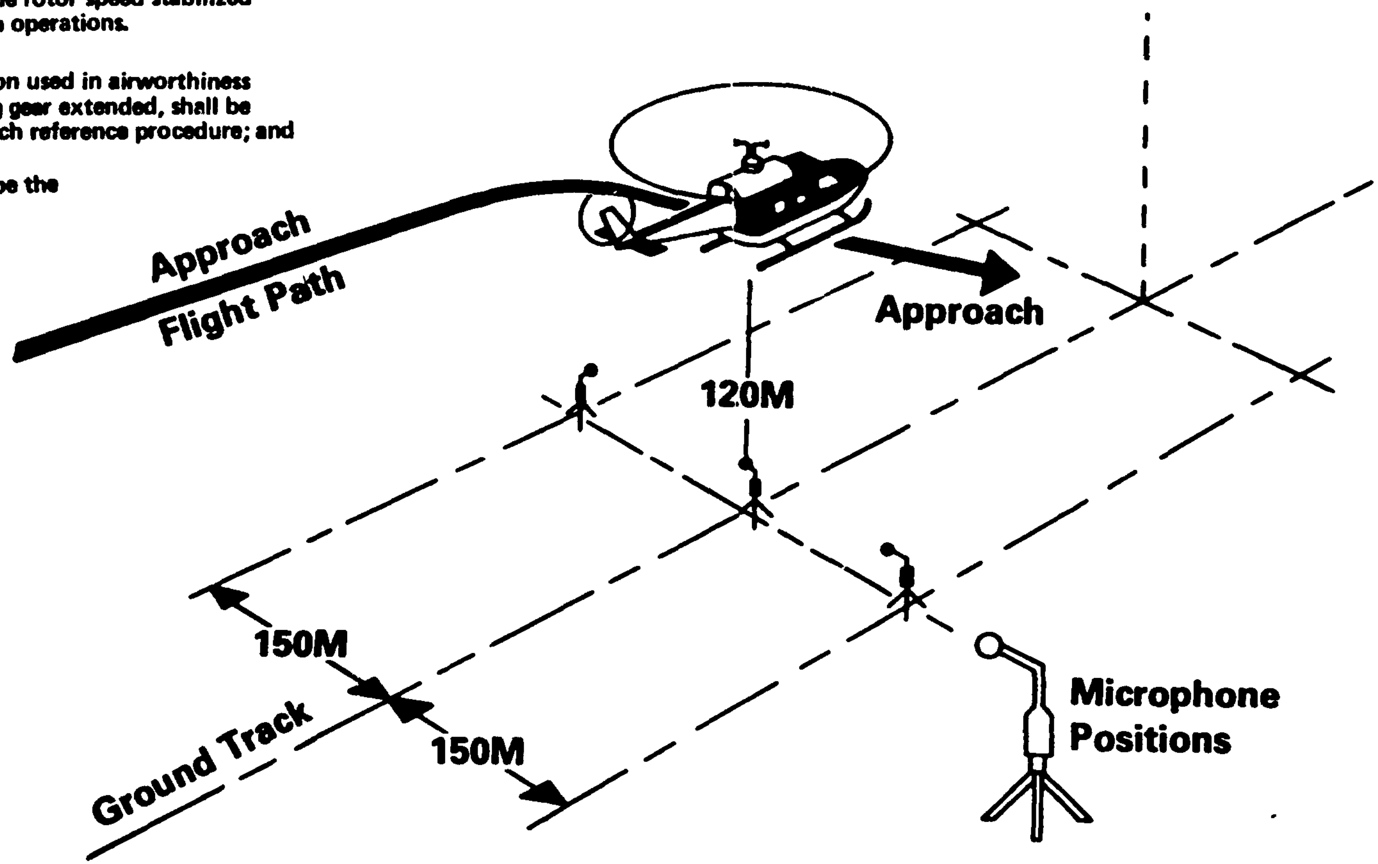


FIGURE 7.3

Helicopter Flyover Noise Tests

The flyover procedure shall be established as follows:

a) the helicopter shall be stabilized in level flight overhead the flight path reference point at a height of 150 m (492 ft);

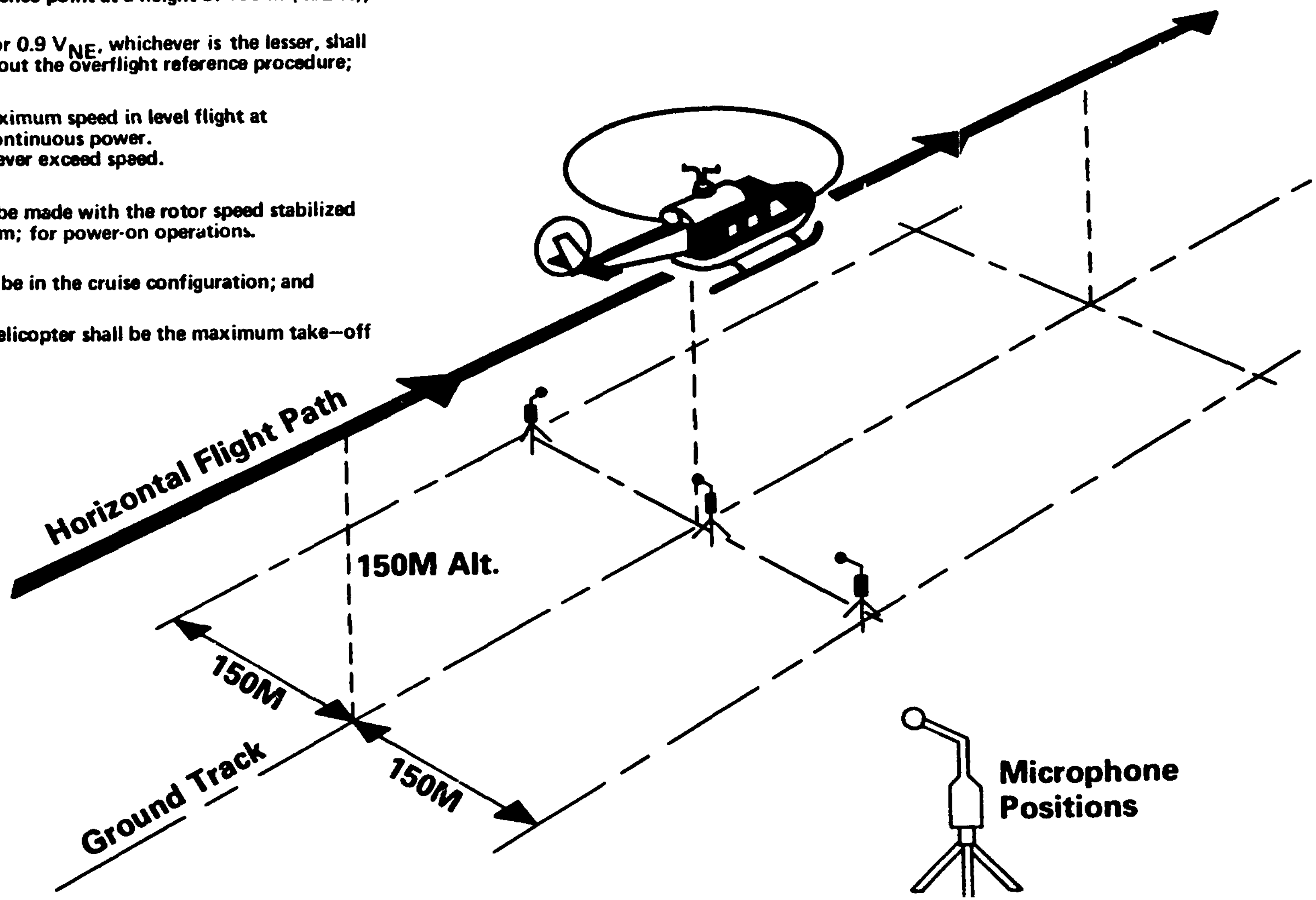
b) a speed of 0.9 V_H or 0.9 V_{NE}, whichever is the lesser, shall be maintained throughout the overflight reference procedure;

<u>NOTE</u>: V_H is the maximum speed in level flight at maximum continuous power.
V_{NE} is the never exceed speed.

c) the overflight shall be made with the rotor speed stabilized at the maximum rpm; for power-on operations.

d) the helicopter shall be in the cruise configuration; and

e) the weight of the helicopter shall be the maximum take-off weight.



DOCUMENTARY ANALYSES

8.0 Documentary Analyses/Processing of Trajectory and Meteorological Data - This section contains analyses which were performed to document the flight path trajectory and upper air meteorological characteristics during the Aerospatiale AS 350D AStar test program.

8.1 Photo-Altitude Flight Path Trajectory Analyses - Data acquired from the three centerline photo-altitude sites were processed on an Apple IIe microcomputer using a VISICALC® (manufacturer) electronic spreadsheet template developed by the authors for this specific application. The scaled photo-altitudes for each event (from all three photo sites) were entered as a single data set. The template operated on these data, calculating the straight line slope in degrees for the helicopter position between each pair of sites. In addition, a linear regression analysis was performed in order to create a straight line approximation to the actual flight path. This regression line was then used to compute estimated altitudes and CPA's (Closest Point of Approach) referenced to each microphone location (Note: Photo sites were offset from microphone sites by 100 feet). The results of this analysis are contained in the tables of Appendix F.

Discussion - While the photo-altitude data do provide a reasonable description of the helicopter trajectory and provide the means to effect distance corrections to a reference flight path (not implemented in this report), there is the need to exercise caution in interpretation of the data. The following excerpt makes an important point for those trying to relate the descent profiles (in approach test series) to resulting acoustical data.

> In our experience, attempts by the pilot to fly down a very narrow VASI beam produce a continuously varying rate of descent. Thus while the <u>mean</u> flight path is maintained within a reasonable degree of <u>test precision</u>, the rate of descent (important parameter connected with blade/vortex interactions) at any instant in time may vary much more than during <u>operational</u> flying. (Ref. 8)

Further, care is necessary when using the regression slope and the regression estimated altitude; one must be sure that the site-to-site slopes are similiar (approximate constant angle) and that they are in agreement with the regression slope. If these slopes are not in agreement, then use photo altitude data along with the site-to-site slopes in calculating altitude over microphone locations. Also included for reference are the mean values and standard deviations for the data collected at each site, for each series. These data display the variability in helicopter position within a given test series.

8.2 Meteorological Data - This section documents the course variation in upper air meteorological parameters as a function of time for the June 8 test program. References are also made to surface meterological data.

The National Weather Service office in Sterling, Virginia provided preliminary data processing resulting in the data tables shown in Appendix H. Supplementary analyses were then under taken to develop time histories of various parameters over the period of testing for selected altitudes. Each time history was constructed using least square linear regression techniques for the five available data points (one for each launch). The plots attempt to represent the gross (macro) meteorological trends over the test period.

Temperature: Figure 8.1 shows the time history of temperature (P.C.) for June 8, 1983. Between hours of 8 and 11 a.m. it can be seen that the surface temperture remains fairl constant at approximately 27°C, while the upper altitude's (above 500') show a significant increase in temperture over the same period. Aside from the surface temperature remaining fairly constant (approximately 27°C), Figure 8.1 shows a normal lapse rate of (2-3°C)/1000 ft. above the 500 ft. level; where as the difference between the ground and 500 ft. levels is a marked 10°C/1000 ft., which is consistent with solar heating of the earth's surface as a function of time. Static, Takeoff, and Approach operations were conducted during this time frame. Level flyover operations were conducted between

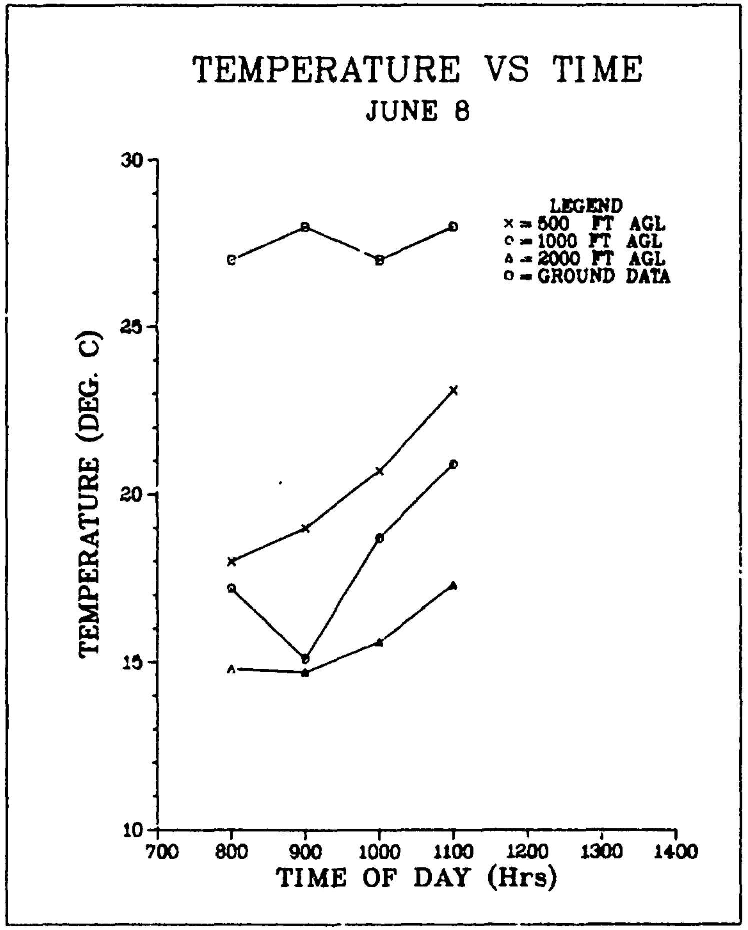


FIGURE 8.1

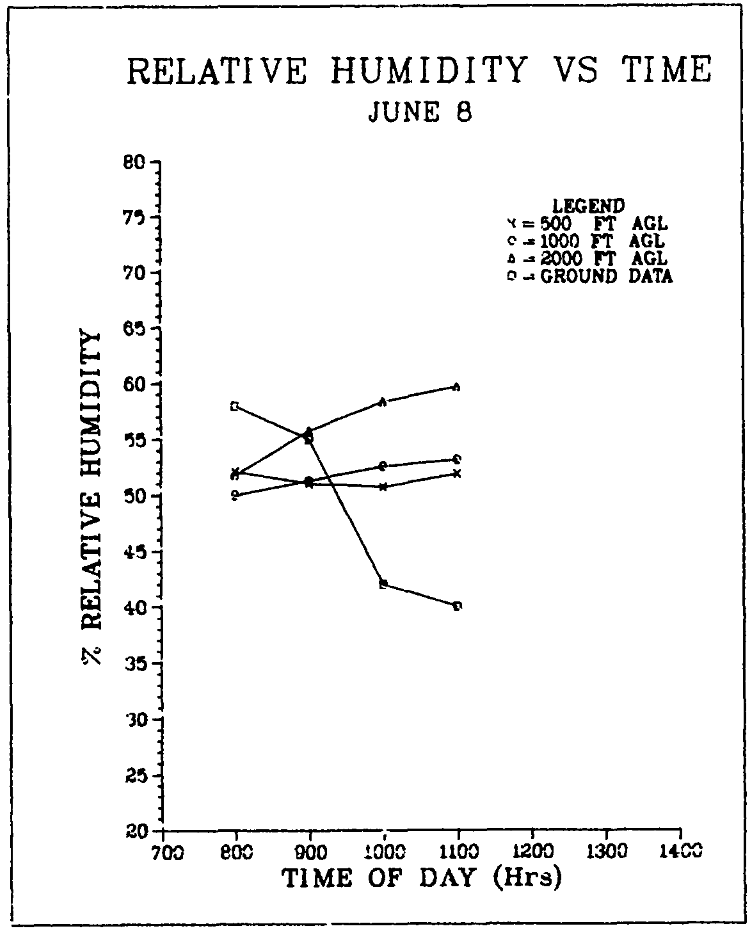


FIGURE 8.2

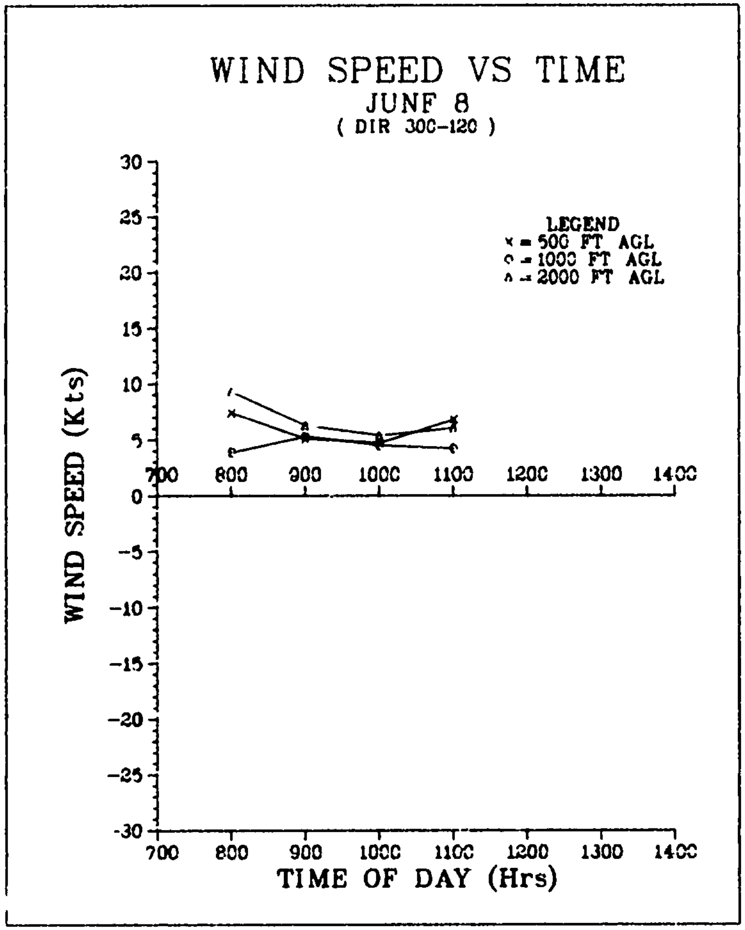
11:00 a.m. and 12:00 p.m. and it is expected that these same conditions existed during these operations also. The effects of temperture during the test period are most notable in performance characteristics (i.e., rate of climb) of the aircraft.

Relative Humidity: Figure 8.2 shows the time history of Relative Humidity (% percent) for June 8, 1983. It is seen that surface moisture is burnt off as a function of time due to solar heating as expected. However, Figure does not show the expected increase in surface temperature that would precipitate such a drastic decrease in relative humidity. Therefore some meterological phenomena (? fog) must have existed during this time period that would account for such major inconsistencies.

Wind Data: Figures 8.3 and 8.4 show the Head/tail and cross wind components versus the time of day for June 8, 1983. During the hours of 8 and 11 a.m., one observes (Figure 8.3) a steady 7-8 kts head/tail component, depending on the direction of flight.

Takeoffs were flown in the 300° direction, while approach operations were flown in the 120° direction, suggesting a head/tail wind contribution respectively to the airspeed of the aircraft. The crosswind components of the wind vector are plotted in Figure 8.3 over the same period of time. Level flyover operations were conducted between 11:00 a.m. and 12:00 p.m.

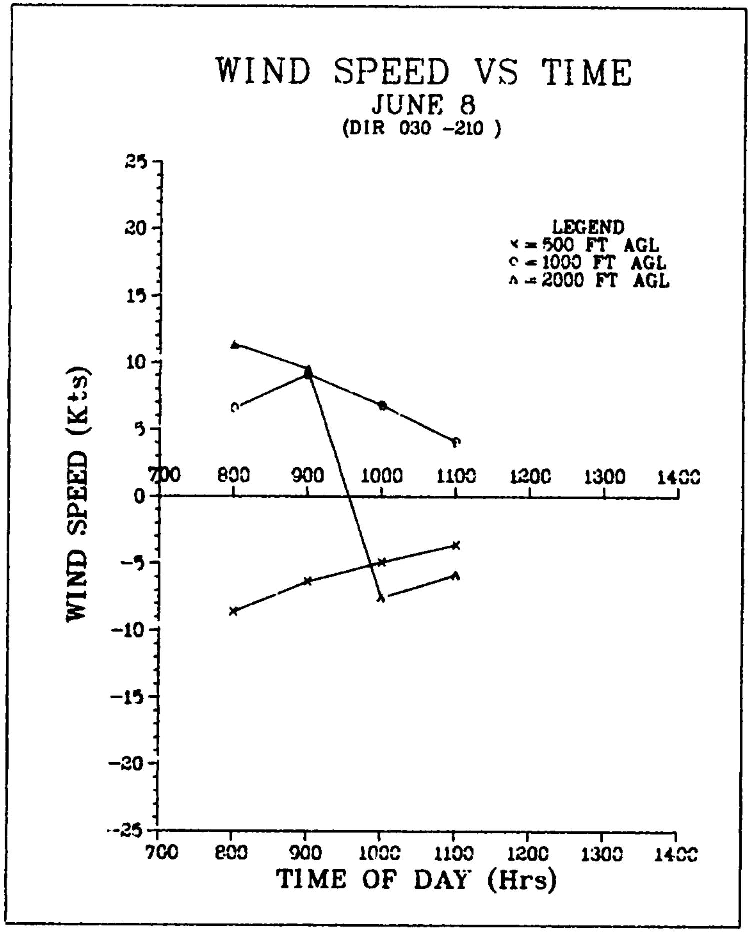
FIGURE 8.3



HEAD/TAIL WIND

This plot indicates a headwind for operations in the 300 degree magnetic direction.

FIGURE 8.4



CROSS WIND

This plot indicates a right side crosswind for operations in the 120 degree magnetic direction.

EXPLORATORY ANALYSES AND DISCUSSIONS

9.0 Exploratory Analyses and Discussion - This section is comprised of a series of distinct and separate analyses of the data acquired with the Aerospatiale AS 350D AStar test helicopter. In each analysis section an introductory discussion is provided describing pre-processing of data (beyond the basic reduction previously described), followed by presentation of either a data table, graph(s), or reference to appropriate appendices. Each section concludes with a discussion of salient results and presentation of conclusions.

The following list identifies the analyses which are contained in this section.

9.1 Variation in noise levels with airspeed for level flyover operations

9.2 Static data analysis: source directivity and hard vs. soft propagation characteristics

9.3 Duration effect analysis

9.4 Analysis of variability in noise levels for two sites equidistant over similar propagation paths

9.5 Variation in noise levels with airspeed and rate of descent for approach operations

9.6 Analysis of ground-to-ground acoustical propagation for a nominally soft propagation path

9.7 Air-to-ground acoustical propagation analysis

9.1 Variation in Noise Levels with Airspeed for Level Flyover Operations - This section analyzes the variation in noise levels for level flyover operations as a function of airspeed. Data acquired from the centerline-center location (site 1) magnetic recording system (see Appendix A) have been utilized in this analysis. All data are "as measured", uncorrected for the minor variations in altitude from event to event.

The data scatter plotted in Figures 9.1 through 9.4 represent individual noise events (for each acoustical metric). The line in each plot links the average observation at each target airspeed.

Discussion - The plots show the general trend that can be expected with an increase in airspeed during level flyover operations. It has been observed that as a helicopter increases its airspeed, two acoustically related events take place. First, the noise event duration is decreased as the helicopter passes more quickly. Second, the source acoustical emission characteristics change. These changes reflect the aerodynamic effects which accompany an increase in speed. At speeds higher than the speed for minimum power, the power required (torque) increases with an increase in airspeed. These influences lead to a noise intensity versus airspeed relationship generally approximated by a parabolic curve. At first, noise levels decrease with airspeed, then an upturn occurs as a consequence of increasing advancing blade tip Mach number effects, which in turn generates impulsive noise.

The noise versus airspeed plots for the AStar are shown for various acoustical metrics in Figures 9.1 through 9.4.

The AStar airspeed/noise level relationships follow a very shallow parabolic pattern characterized by an upturn at approximately 115 mph. A similar curve shape is observed for each metric.

Advancing tip Mach Number relationships corresponding to airspeeds are presented in the table below.

Table 9.1

IAS (MPH)	M_A
80	.7
90	.72
100	.73
110	.74
120	.76
130	.77
140	.78
150	.79

It is seen that the curves begin to bend upward at an advancing tip Mach number of approximately 0.75. This is a somewhat sooner onset than the trend observed for the Aerospatiale TwinStar where levels increase most rapidly beyond a value of 0.79.

ASTAR LEVEL FLYOVER PLOTS

FIGURE 9.1

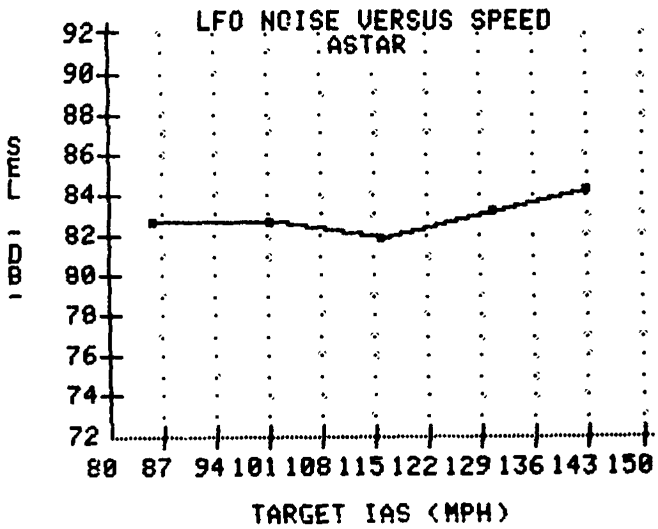


FIGURE 9.2

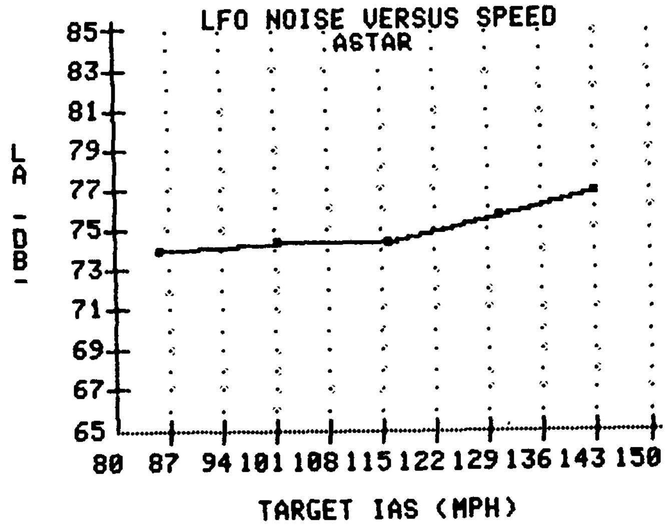


FIGURE 9.3

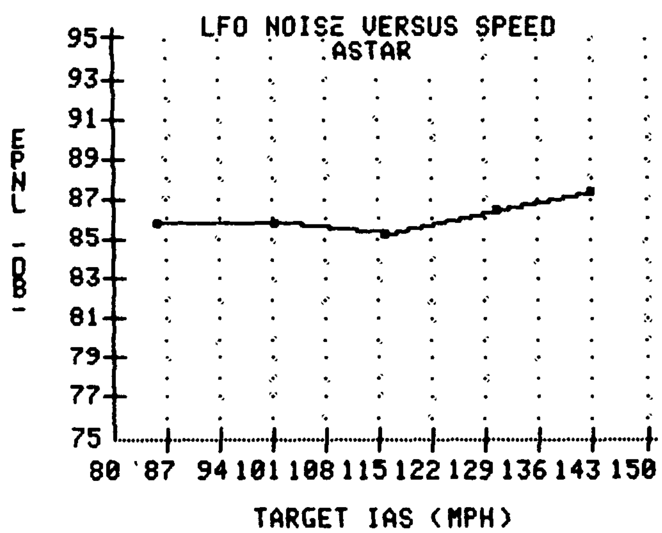
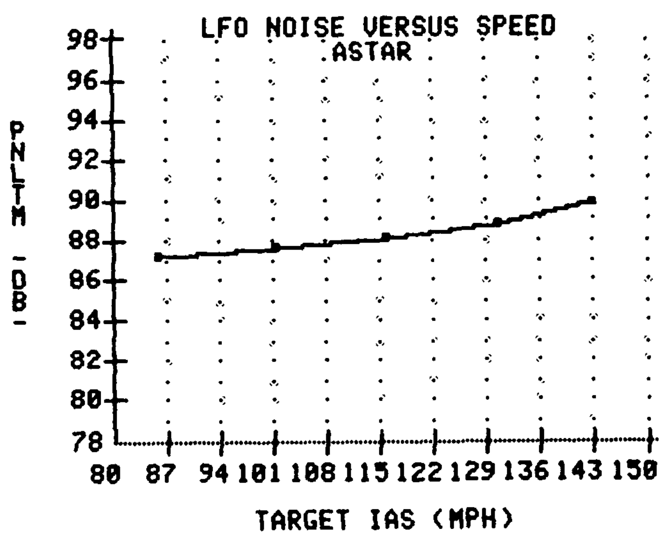


FIGURE 9.4



9.2 Static Operations: Static Operations were conducted on the Aerospatiale AS 350D AStar for three operational configurations on June 8, 1983. Where it has been the case in previous reports (of this series) to graphically display noise levels propagated over hard and soft paths during static operations; it is only possible for one operation for the AStar. During the Ground Idle and Hover-In-Ground-Effect operation the noise levels collected at sites 2 or 5H or both are not available, probably because the levels were below the noise floor of the recording equipment. Appendix C shows the tape recorded noise levels for these operations.

Flight Idle: Figure 9.5 presents data acquired for the Aerospatiale AS 350D AStar during it's Flight Idle static mode propagated across hard and soft paths of equal distance from the Hover point. It can be observed from Figure 9.5 that the AStar displays an acoustic emission pattern that is pronounced on the left side of the aircraft. In fact the maximum noise occurs for the 270° emission angle over the hard path where as the soft path remains relatively stable across all emission angles. The maximum difference between hard and soft path occurs therefore at the 270° emission angle and is about 12 dB.

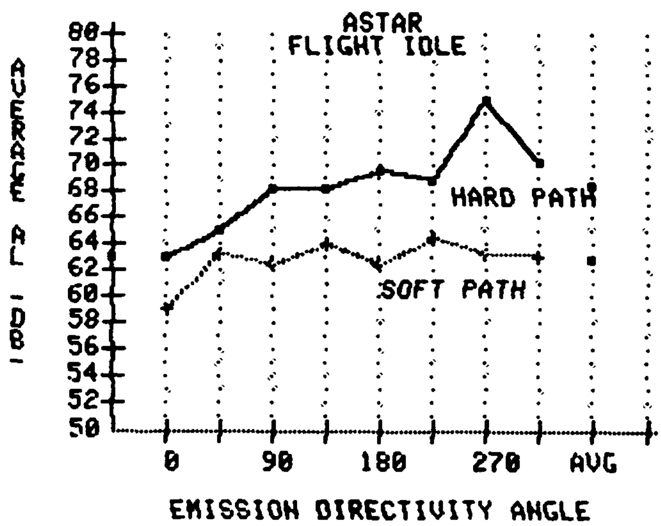
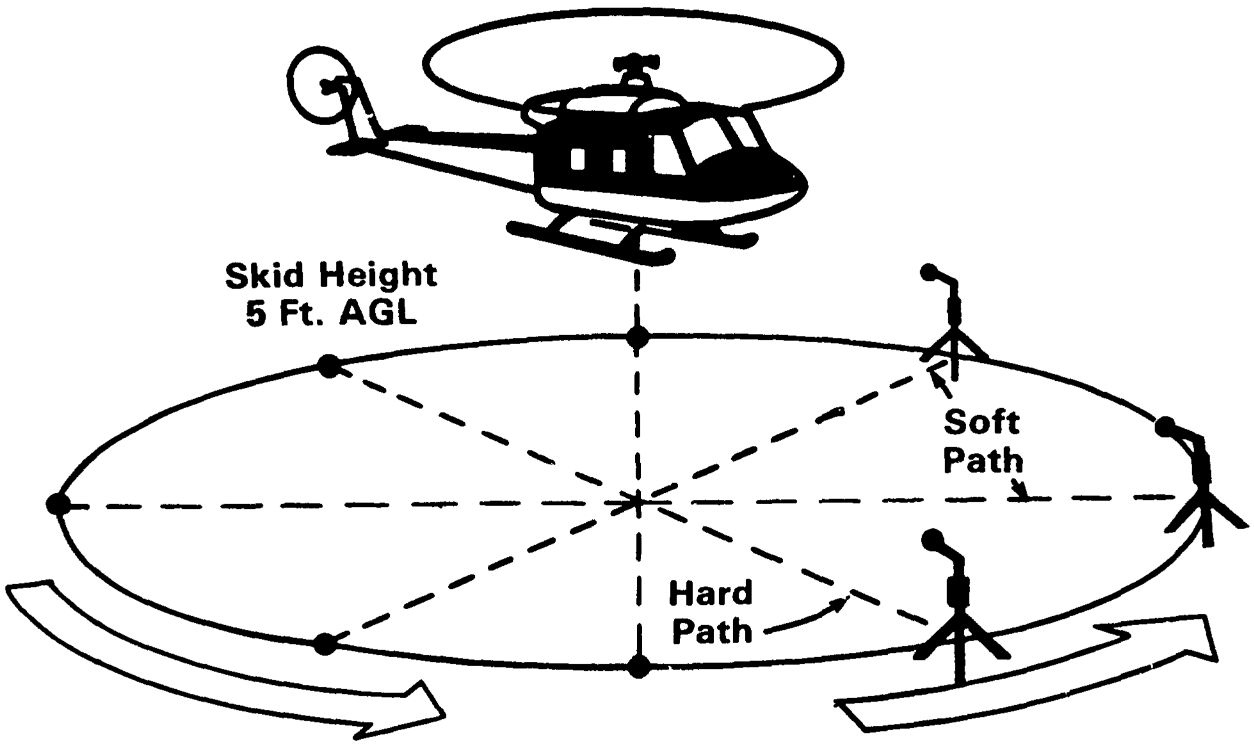


FIGURE 9.5

Helicopter Hover Noise Test



Helicopter Rotates in 45° Steps
8 Microphone Positions

FIGURE 9.6

9.3 Analysis of Duration Effects - This section consists of three parts, each developing relationships and insights useful in adjusting from one acoustical metric to another (typically from a maximum level to an energy dose). Each subsection quantitatively addresses the influence of the event duration.

9.3.1 Relationships Between SEL, AL and T-10 - This analysis explores the relationship between the helicopter noise event (intensity) time-history, the maximum intensity, and the total acoustical energy of the event. Our interests in this endeavor include the following:

1) It is often necessary to estimate an acoustical metric given only part of the information required.

2) The time history duration is related to the ground speed and altitude of a helicopter. Thus any data adjustments for different altitudes and speeds will affect duration time and consequently the SEL (energy metric). The requirement to adjust data for these effects often arises in environmental impact analysis around heliports. In addition, the need to implement data corrections in helicopter noise certification tests further warrants the study of duration effects.

Two different approaches have been utilized in analyzing the effect of event 10-dB-down duration (DURATION or T_{10}) on the accumulated energy dose (Sound Exposure Level).

Both techniques are empirical, each employing the same input data but using a different theoretical approach to describe duration influences.

The fundamental question one may ask is "If we know the maximum A-weighted sound level and we know the 10-dB-down duration time, can we with confidence estimate the acoustical energy dose, the Sound Exposure Level?" A rephrasing of this question might be: If we know the SEL, the AL, and the 10-dB-down duration time (DURATION), can we construct a universal relationship linking all three?

Both attempts to establish relationships involve taking the difference between the SEL and AL (delta), placing the delta on the left side of the equation and solving as a function of duration. The form which this function takes represents the differences in approach.

In the first case, one assumes that delta equals some constant K(DUR) multiplied by the base 10 logarithm of DURATION, i.e.,

$$\mathrm{SEL} - \mathrm{AL} = K(\mathrm{DUR}) \times \mathrm{LOG}(\mathrm{DURATION})$$

In the second case, we retain the 10 x LOG dependency, consistent with theory, while achieving the equality through the shape factor, Q, which is some value less than unity i.e., SEL-AL = 10 x LOG(Q x DURATION). In a situation where the flyover noise event time history was represented by a step function or square wave shape, we would expect to see a value of Q equaling precisely one. However, we know that the time history for typical non-impulsive event is much closer in shape to an isoceles triangle and consequently likely to have a Q much closer to 0.5.

Another possible use of this analytical approach for the assessment of duration effects is in correcting noise certification test data which were acquired under conditions of nonstandard ground speed and/or distance.

Discussion - Each of the noise template data tables lists both of the duration related figures of merit for each individual event (see Appendix B). One immediate observation is the apparent insensitivity of the metrics to changes in operation, and the extremely small variation in the range of metric values, nearly a constant Q = 0.4 and a stable k(A) value of 7.0. Data have been plotted in Figure 9.7 which shows the minor variation (a transition from 0.4 to 0.5 at 130 mph) of both metrics with airspeed for the level flyover operations for the microphone site 1 direct read system. The lack of variation in the parameters suggests that a simple and nearly constant dependency exists between SEL, AL, and log DURATION, relatively unaffected by changes in airspeed, in turn suggesting a consistent time history shape for the range of airspeeds evaluated in this test. As SEL increases with airspeed, the increase appears to be related to increase in AL_M but mitigated in part by reduced duration time (and a nearly constant k(A)=7).

It is interesting to note that similar results were found for the other helicopters tested (Ref. 10 - 13), (Ref. 10) suggesting that different helicopter models will have similar values for K and Q. This implies that it would be unnecessary to develop unique constants for different helicopter models for use in implementing duration corrections.

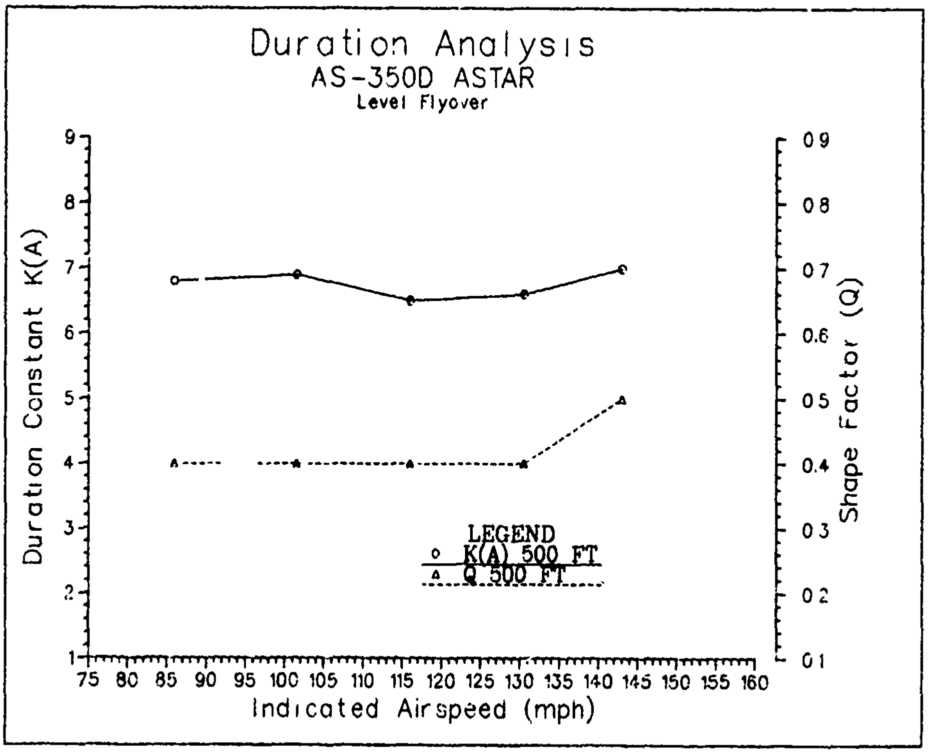


FIGURE 9.7

9.3.2 <u>Estimation of 10 dB Down Duration Time</u> - In some cases, one does not have access to 10 dB down duratin time (DURATION) information. A moderate to highly reliable technique for estimating DURATION for the AStar is developed empirically in this section.

The distance from the helicopter to the observer at the closest point of approach (expressed in feet) divided by the airspeed (expressed in knots) yields a ratio, hereafter referred to as (D/V). This ratio has been compiled for various test series for micorphone sites 1,2 and 3 and has been presented in Table 9.2 along with the average DURATION expressed in seconds. A linear regression was performed on each data set in Table 9.2 and these results are also displayed in Table 9.2. Here one observes generally high correlation coefficients, in the range of 0.75 to 0.92.

TABLE 9.2

DURATION (T-10) REGRESSION ON D/V

HELICOPTER: ASTAR

SITE 1

TEST SERIES	COCKPIT PHOTO DATA V AVG	AVG DUR(A)	AVG EST ALT	D/V		
A	130	14.4	560.1	4.3	LINEAR	
B	118	14.8	529	4.5	REGRESSION	
C	101.75	16.1	558	5.5		
D	126.75	24.6	1070	[illegible].4	SITE #1	
E	60.86	24.3	586.9	9.6		
F	64.78	14.7	355.5	5.5	SLOPE	2.19
G	73.6	17.7	542.9	7.4	INTERCEPT	3.88
H	75.67	14.7	395.3	5.2	R SQ.	.89
M	83	19.2	538.2	6.5	R	.95
N	142.67	11.7	568.3	4	SAMPLE	10

SITE 2

TEST SERIES	COCKPIT PHOTO DATA V AVG	AVG DUR(A)	AVG EST ALT	D/V		
A	130	15.1	745.8	5.7	LINEAR	
B	118	15.8	722.7	6.1	REGRESSION	
C	101.75	18.5	744	7.3		
D	126.75	26.5	1177.7	9.3	SITE #2	
E	60.86	27.2	766.5	12.6		
F	64.78	26.5	607	9.4	SLOPE	2.04
G	73.6	24.5	733.1	10	INTERCEPT	4.82
H	75.67	27.6	631.2	8.3	R SQ.	.73
M	83	21.1	729.6	8.8	R	.86
N	142.67	14.6	751.8	5.3	SAMPLE	10

SITE 3

TEST SERIES	COCKPIT PHOTO DATA V AVG	AVG DUR(A)	AVG EST ALT	D/V		
A	130	14.6	744.8	5.7	LINEAR	
B	118	15.4	721.9	6.1	REGRESSION	
C	101.75	23.4	743.4	7.3		
D	126.75	25	1177	9.3	SITE #3	
E	60.86	23.4	749.2	12.3		
F	64.78	20.6	603.3	9.3	SLOPE	1.3[illegible]
G	73.6	18.8	719.5	9.8	INTERCEPT	8.33
H	75.67	14.5	626.8	8.3	R SQ.	.46
M	83	21.2	728.1	8.8	R	.68
N	142.67	14.3	752.5	5.3	SAMPLE	10

The regression equations relating DURATION with D/V are given as

Centerline center, Microphone Site 1:
$T_{10} = [2.2 \times (D/V)] + 3.8$

Sideline South, Microphone Site 2:
$T_{10} = [2.0 \times (D/V)] + 4.8$

Sideline North, Microphone Site 3:
$T_{10} = [1.3 \times (D/V)] - 8.3$

It is interesting to note that each relationship has a similar slope but differing intercept values. Because the regression analyses were conducted for a population consisting of all test series (which involved the operations in both directions) it is not possible to comment on left-right side acoustical directivity of the helicopter.

It is worth noting that the general trend observed for the AStar (longer sideline duration) is consistent with results seen for the TwinStar (Ref. 13). It appears necessary to consider carefully helicopter specific characteristics in estimating SEL or other energy-dose acoustical metrics at sideline locations. It is also significant to note that slopes computed above for the AStar are very similar (approximately 2) to those observed for both the TwinStar and the Hughes 500D.

<u>Synthesis of Results</u> - It is now possible to merge the results of Section 9.3.1 with the finding above in establishing a relationship between (D/V) and SEL and AL. Given the approximation: SEL = AL + (10*LOG(0.45*DURATION)), it is possible to insert the computed value for T_{10} (DURATION) into the equation and arrive at the desired relationship.

9.3.3 <u>Relationship Between SEL minus AL and the Ratio D/V</u> - The difference between SEL and AL_M or conversely, EPNL and $PNLT_M$ (in a

certification context), is referred to as the DURATION CORRECTION. This difference is clearly controlled by the event T_{10} (10 dB down duration time) and the acoustical energy contained within those bounds. As discussed in previous sections, the T_{10} is highly correlated with the ratio D/V. This analysis establishes a direct link between D/V and the DURATION CORRECTION in a manner similar to that employed in Section 9.3.2. Table 9.3 provides a summary of data used in regression analyses for microphones 1, 2 and 3. The regression equations, along with other statistical information, are provided in Table 9.3 also.

It is encouraging to note the strong correlations (coefficients greater than 0.73) which suggest that SEL can be estimated directly (and with confidence) from the AL_M and knowledge of D/V. It is also interesting to note the similar regression equations. As mentioned in Section 9.3.2, it is difficult to comment explicitly (and quantitatively) on source directivity because operations were conducted in both directions. Regardless, one can see that centerline/sideline differences do exist. The reader is cautioned, however, not to expect these relationships to necessarily hold for D/V ratios beyond the range explored in this analysis.

TABLE 9.3

SEL-ALm REGRESSION ON D/V

HELICOPTER: ASTAR

SITE 1

TEST SERIES	COCKPIT PHOTO DATA V AVG	AVG SEL-ALm	AVG EST ALT	D/V		
A	130	7.6	560.1	4.3	LINEAR	
B	118	7.6	529	4.5	REGRESSION	
C	101.75	8.3	558	5.5		
D	126.75	10	1070	8.4	SITE #1	
E	60.86	9.9	586.9	9.6		
F	64.78	8.6	355.5	5.5	SLOPE	.49
G	73.6	9.1	542.9	7.4	INTERCEPT	5.53
H	75.67	7.7	395.3	5.2	R SQ.	.93
M	83	8.6	538.2	6.5	R	.96
N	142.67	7.5	568.3	4	SAMPLE	10

SITE 2

A	130	7.8	745.8	5.7	LINEAR	
B	118	8.2	722.7	6.1	REGRESSION	
C	101.75	8.8	744	7.3		
D	126.75	10.3	1177.7	9.3	SITE #2	
E	60.86	10.9	766.5	12.6		
F	64.78	10.3	607	9.4	SLOPE	.47
G	73.6	10.6	733.1	10	INTERCEPT	5.51
H	75.67	10.3	631.2	8.3	R SQ.	.82
M	83	9	729.6	8.8	R	.91
N	142.67	8.1	751.8	5.3	SAMPLE	10

SITE 3

A	130	7.9	744.8	5.7	LINEAR	
B	118	8.4	721.9	6.1	REGRESSION	
C	101.75	9.6	743.4	7.3		
D	126.75	10	1177	9.3	SITE #3	
E	60.86	9.9	749.2	12.3		
F	64.78	9	603.3	9.3	SLOPE	.26
G	73.6	8.7	719.5	9.8	INTERCEPT	6.8
H	75.67	8.4	626.8	8.3	R SQ.	.53
M	83	9.3	728.1	8.8	R	.73
N	142.67	8	752.5	5.3	SAMPLE	10

9.4 Analysis of Variability in Noise Levels for Two Sites Over Similiar Propagation Paths - This analysis examines the differences in noise levels observed for two sites each located 500 feet away from the hover point over similar terrain. The objective of the analysis was to examine variability in noise levels associated with ground-to-ground propagation over nominally similar propagation paths. The key word in the last sentence was nominally,...in fact the only difference in the propagation paths is that microphone 1H was located in a slight depression, (elevation is minus 2.5 feet relative to the hover point), while site 2 has an elevation of plus 0.2 feet relative to the hover point. This is a net difference of 2.7 feet over a distance of 500 feet. This configuration serves to demonstrate the sensitivity of ground-to-ground sound propagation over minor terrain variations.

Discussion - The results presented in Tables 9.4 and 9.5 show the observed differences in time average noise levels for eight directivity angles and the spacial average. In each case, magnetic recording data (Appendix C) have been used in the analyses. It is observed that significant differences in noise level occur for the low angle (ground-to-ground) propagation scenarios.

It is speculated that very minor variations in site elevation (and resulting microphone placement) lead to site-to-site differences in the measured noise levels for static operations. Differences in microphone height result in different positions within the interference pattern of incident and reflected sound waves. It is also appropriate to consider whether variation in the acoustical source characteristics contributes to

noise level differences. In this analysis, magnetic recording data from microphone site 2 are compared with data recorded at site 1H approximately one minute later. That is, the helicopter rotated 45 degrees every sixty seconds, in order to project each directivity angle (there is a 45 degree separation between the two sites). In addition to source variation, it is also possible that the helicopter "aim," based on magnetic compass readings may have been slightly different in each case, resulting in the projection of different intensities and accounting for the observed differences. A final item of consideration is the possibility of refraction of sound waves (due to thermal or wind gradients) resulting in shadow regions. It is worth noting that, generally, similar results have been observed for other test helicopters (Bell 222, ref. 10; Aerospatiale Dauphin, ref. 11, Hughes 300D, Ref. 12; TwinStar, Ref. 13). Regardless of what the mechanisms are which create this variance, one perceives that static operations display intrinsically variant sound levels, in both direction and time, and also potentially variant (all other factors being normalized) for two nominally identical propagation paths.

TABLE 9.4

COMPARISON OF
NOISE VERSUS DIRECTIVITY ANGLES
FOR
TWO SOFT SURFACES

HELICOPTER: ASTAR

OPERATION: HOVER-IN-GROUND

	DIRECTIVITY ANGLES (DEGREES)								Lav(360 DEGREE)	
SITE	0	45	90	135	180	225	270	315	ENERGY	ARITH.
	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ
SOFT 1H	61.3	63.8	61.8	63.8	66.5	67.2	64.2	65.2	64.6	64.2
SOFT 2	66.7	66.8	67.3	71.2	72.7	69.6	68.1	67.7	69.3	68.8
DELTA dB*	5.4	3	5.5	7.4	6.2	2.4	3.9	2.5	4.7	4.6

* DELTA dB = (SITE 2) MINUS (SITE 1H)

TABLE 9.5

COMPARISON OF
NOISE VERSUS DIRECTIVITY ANGLES
FOR
TWO SOFT SURFACES

HELICOPTER: ASTAR

OPERATION: FLIGHT IDLE

	DIRECTIVITY ANGLES (DEGREES)								Lav(360 DEGREE)	
SITE	0	45	90	135	180	225	270	315	ENERGY	ARITH.
	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ	LEQ
SOFT 1H	56.1	56.5	60.3	59.3	59.5	60.3	61.1	60.3	59.5	59.2
SOFT 2	59.1	63.3	62.5	64.1	62.5	64.5	63.2	63.1	63	62.8
DELTA dB*	3	6.8	2.2	4.8	3	4.2	2.1	2.8	3.5	3.6

* DELTA dB = (SITE 2) MINUS (SITE 1H)

9.5 Variation in Noise Levels With Airspeed for 6 and 9 Degree Approach Operations - This section examines the variation in noise level for variations in approach angle. This analysis has two objectives: first, to evaluate further the realm of "Fly Neighborly" operating possibilities, and second, to consider whether or not it is reasonable to establish a range of approach operating conditions for noise certification testing. Data is presented for the 6 and 9 degree approache. The appropriate series "As Measured" acoustical data contained in Appendix A, have been tabulated in Table 9.6 and plotted (corrected for the minor differences in altitude) in Figures 9.8 and 9.9.

Discussion - In the approach operational mode, impulsive (banging or slapping) acoustical signatures are a result of the interaction between vortices (generated by the fundamental rotor blade action) colliding with successive sweeps of the rotor blades (see Figure 9.10). As reported in reference 11, for certain helicopters, maximum interaction occurs at airspeeds in the 50 to 70 knot range, at rates-of-descent ranging from 200 to 400 feet per minute. When the rotor blade enters the vortex region, it experiences local pressure fluctuations and associated changes in blade loading. These perturbations and resulting pressure gradients generate the characteristic impulsive signature.

The data presented in Figures 9.9 and 9.10 for the three centerline locations (150 meter spacing) portray the variation in noise level along the ground track as the approach angle (rate of descent) changes (from 6

to 9 degrees) with airspeed held nominally constant. The 9 degree approach achieves a 2 dB reduction in the intensity metric L_A at sites 1 and 5. There is practically no improvement at site 4. The reduction in the energy dose metric SEL is more consistent from site to site with a value of approximately 2dB. The change in the rate of descent changes the vertical location of the tip vortices with respect to the blades, thereby changing the relative degree of interaction. From a certification stand point, it is clear that the 6 degree approach would present greater noise than the alternative procedure examined.

In the context of the "Fly Neighborly" program, it is worth acknowledging the potential tradeoff (and classic problem) of diminishing noise levels at one location while increasing noise levels at another. In this regard, it is considered important to further evaluate candidate "Fly Neighborly" operations at a matrix of locations in the vicinity of the overflight corridor.

A recent study conducted in France (ref. 12) included a matrix of 24 microphones. While cost and logistical constraints make this unrealistic for evaluation of each civil transport helicopter, one would be prudent to evaluate several centerline and sideline microphone locations in any in-depth "Fly Neighborly" flight test.

Two other points of concern in developing "Fly Neighborly" procedures are safety and passenger comfort. Rates of descent, airspeed, initial approach altitude and "engine-out" performance are all factors requiring careful consideration in establishing a noise abatement approach. Finally, while certain operational modes may significantly reduce noise levels, there may be an unacceptable acceleration /deceleration or rate-of-descent imposed on passengers. This is clearly an important concern in commercial air-shuttle operations.

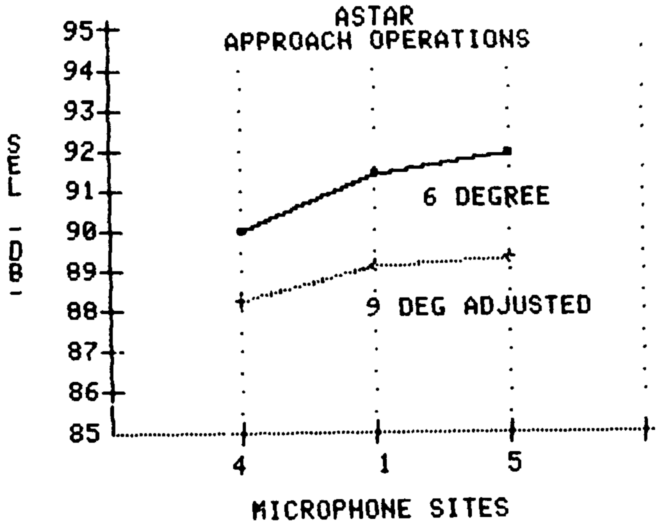


FIGURE 9.8

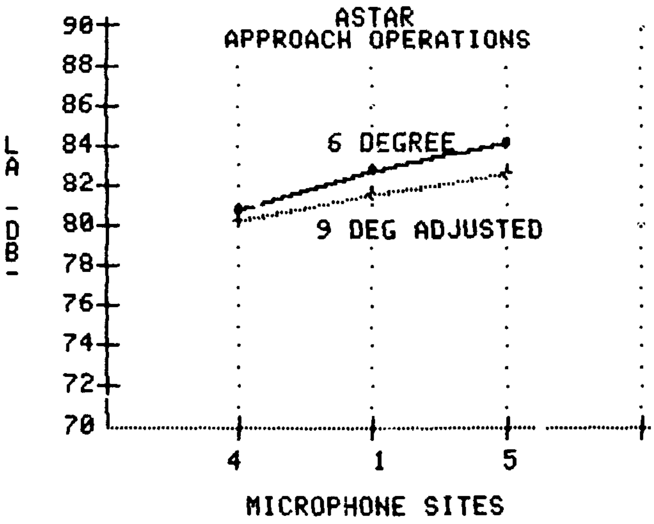


FIGURE 9.9

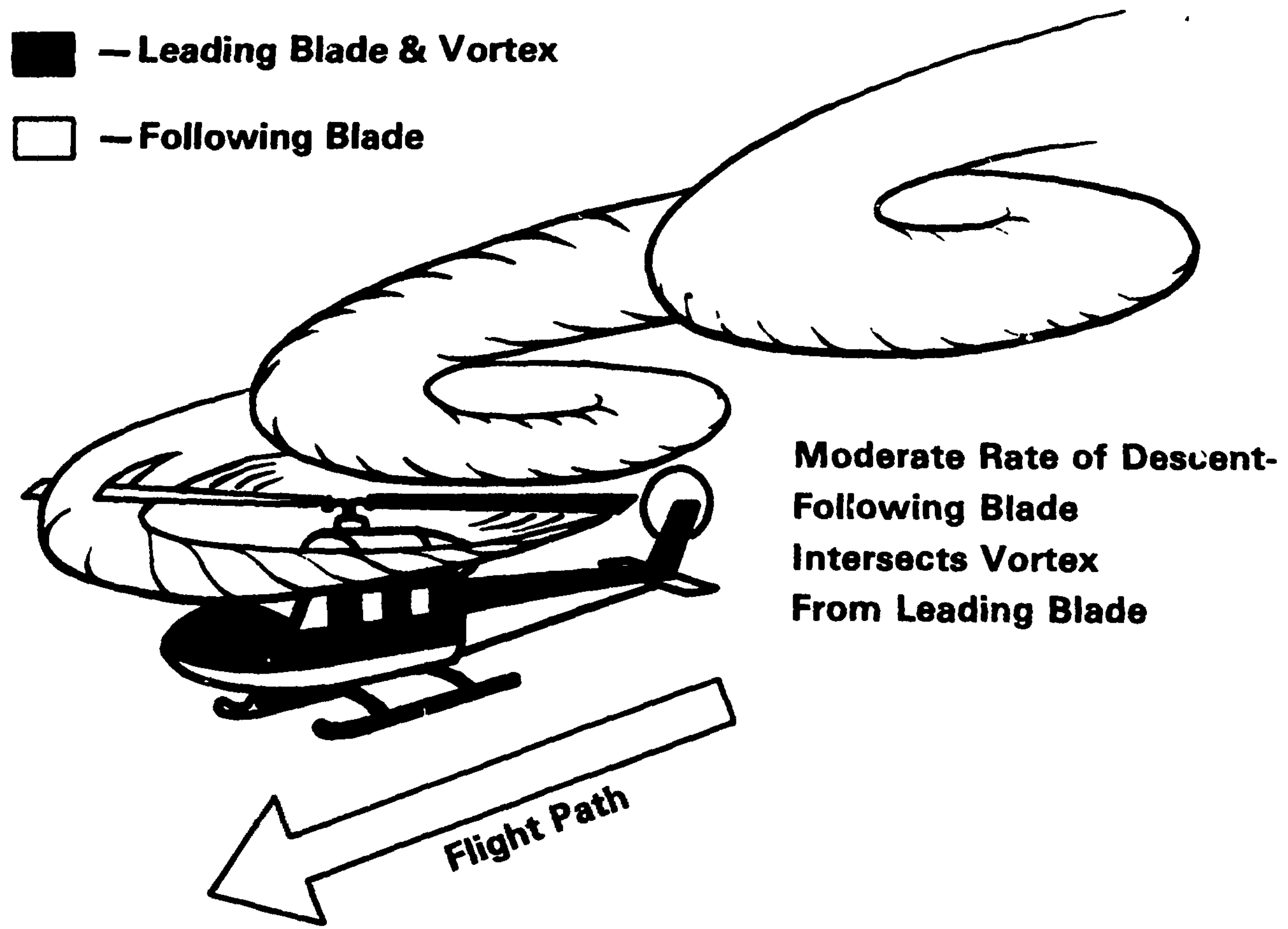
Table 9.6

APPROACH ADJUSTMENT

	Average Altitude	Average AL	Average SEL
6° Approach	348.3	82.8	91.4
9° Approach	384.8	80.6	88.4
9° Adjusted approach	384.8	81.6	88.9

Figure 9.10

Tip Vortex Interaction



9.6 Analysis of Ground-to-Ground Acoustical Propagation

9.6.1 Soft Propagation Path - This analysis involves the empirical derivation of propagation constants for a nominally level, "soft" path, a ground surface composed of mixed grasses. As discussed in previous analyses, there are several physical phenomena that influence the diminution of sound over distance. Among these phenomena, spreading loss, ground-to-ground attenuation and refraction are considered dominant in controlling the observed propagation constants.

A-weighted L_{eq} data for the three static operational modes- HIGE, Flight Idle, and Ground Idle- have been analyzed in each case for eight different directivity angles. Direct read acoustical data from sites 2 and 4H have been used to calculate the propagation constants (K) as follows:

$$K = (Leq(\text{site } 2) - Leq(\text{site } 4))/\text{Log } (2/1)$$

where the Log (2/1) factor represents the doubling of distance dependency (Site 2 is 492 feet and site 4H is 984 feet from the hover point).

For each mode of operation, the average (over various directivity angles) propagation constant has also been computed.

The data used in this analysis (derived from Appendix C) are displayed in Table 9.7 and the results are summarized in Table 9.8.

Discussion - The results shown in Table 9.11 exhibit some minor variation from one operational mode to the next.

In the case of HIGE and Flight Idle (FI), one observes similar and rather consistent average attenuation constants, 37 and 36 respectively. The attenuation constants agree well with results for the Aerospatiale TwinStar (Ref. 13), but tend to differ from results reported for the Hughes 500D (Ref. 12) and the Aerospatiale Dauphin (Ref. 11). As noted in those reports, the relationship $\Delta dB = 25 \log (d1/d2)$ provided a reasonable working approximation for calculating ground-to-ground diminution of A-weighted sound levels over nominally soft paths out to a distance of 1000 feet. In the case of the AStar however, it appears that $\Delta dB - 35 \log(d1/D2)$ would perform better. The results for the Ground Idle operational mode are somewhat surprising, showing a reduction in the rate of attenuation (characterized by a constant of approximately 23).

9.6.2 Hard Propagation Path - This part of the analyses would involve the empirical derivation of constants for sound propagation over a "hard" propagation path, a concrete/composite taxi-way surface. The analytical methods described above (Section 9.7.1) are applicable using data from sites 5H and 7H, respectively 492 and 717 feet from the hover site. The salient feature of this scenario is the presence of a ground surface which is highly reflective and uniform in composition.

TABLE 9.7

STATIC OPERATIONS
DIRECT READ DATA
(ALL VALUES A-WEIGHTED LEQ, EXPRESSED IN DECI

ASTAR

6-8-83

SITE 4H (SOFT SITE)

HIGE	LEQ	FLT IDLE	LEQ	GND IDLE	LEQ
I-0	54.3	J-0A	50.4	J-0B	40.3
I-315	56.8	J-315A	52.3	J-315B	NA
I-270	57.7	J-270A	53.3	J-270B	NA
I-225	55.2	J-225A	52.6	J-225B	NA
I-180	61	J-180A	52.2	J-180B	39
I-135	59.7	J-135A	51.9	J-135B	NA
I-90	56.3	J-90A	51.3	J-90B	NA
I-45	54.9	J-45A	51.8	J-45B	NA

SITE 2 (SOFT SITE)

HIGE	LEQ	FLT IDLE	LEQ	GND IDLE	LEQ
I-0	65.8	J-0A	59.4	J-0B	47.2
I-315	68.2	J-315A	62	J-315B	NA
I-270	68.1	J-270A	63.4	J-270B	NA
I-225	68.2	J-225A	63.7	J-225B	NA
I-180	72.3	J-180A	62.5	J-180B	46.1
I-135	71.4	J-135A	64.3	J-135B	NA
I-90	67.4	J-90A	62	J-90B	NA
I-45	65.4	J-45A	65.2	J-45B	NA

TABLE 9.8

ASTAR

EMPIRICAL PROPAGATION CONSTANTS (K)
FOR SOFT SITES (4H+2)

EMISSION ANGLE	HIGE K	FLT.IDLE K	GND.IDLE K
0	38.33	30.00	23.00
315	38.00	32.33	
270	34.67	33.67	
225	43.33	37.00	
180	37.67	34.33	23.67
135	39.00	41.33	
90	37.00	35.67	
45	35.00	44.67	
AVERAGE	37.87	36.12	23.33

Discussion - The results of the analysis (not shown) revealed absurdly large propagation constant values. This outcome suggests a very high rate of attenuation between site 5H and 7H. The presence of a temperature inversion (very low wind and very high humidity) is probably the source of difficulty, resulting in a shadow region beyond site 5H. It is evident that an isothermal condition with no wind would be the preferred condition for assessment of ground-to-ground propagation. If there is in fact significant shadowing (along the hard path), one may ask why the soft path scenario does not exhibit strange results as well. It can only be speculated that the hard concrete/asphalt surface controlled the temperature profile (and micrometeorology) in the vicinity of 5H and 7H. Conversely, the temperature profile in the vicinity of sites 2 and 4H may have differed significantly, perhaps controlled by the moist grassy surface. In essence, the rate of heat loss, the specific heat, and rate of heating for the dissimilar surfaces may have played a significant role in influencing the test results. Subsequent reports in this series will endeavor to further investigate hard path ground-to-ground propagation.

It is significant to note that similarly strange results (K approximately equal to 50) were acquired for the Hughes 500D (Ref. 12) from test data measured in the early morning with a temperature inversion present.

9.7 Air-to-Ground Acoustical Propagation Analysis - The approach and takeoff operations provided the opportunity to assess empirically the influences of spherical spreading and atmospheric absorption. Through utilization of both noise and position data at each of the three flight track centerline locations (microphones 5, 1, and 4), it was possible to determine air-to-ground propagation constants.

One would expect the propagation constants to reflect the aggregate influences of spherical spreading and atmospheric absorption. It is assumed that the acoustical source characteristics remain constant as the helicopter passes over the measurement array. In past studies (Ref. 10, Ref. 11), it has been observed that this assumption is reasonably valid for takeoff and level flyover operations. In the case of approach, however, significant variation has been evident. Because of the spacial/temporal variability in approach sound radiation along the (1000 feet) segment of interest, approach data have not been utilized in estimating propagation constants. As a final background note relating to the assumption of source stability, a helicopter would require approximately 10 seconds, travelling at 60 knots, to travel the distance between measurement sites 4 and 5.

In both the case of the single event intensity metric, AL, and the single event energy metric, SEL, the difference between SEL and AL is determined for each pair of centerline sites. The delta in each case is then equated with the base ten logarithm of the respective altitude ratio multiplied by the propagation constant (either kA(AL) or kA(SEL), the values to be determined.

Data have also been analyzed from the 500 and 1000 foot level flyover operations and the KP(AL) has been computed. Data were pooled for all centerline sites (5, 1, and 4) in the process of arriving at the propagation constant.

The takeoff analyses are shown in Tables 9.9 and 9.10 and are summarized in Table 9.11. Results of the level flyover calculations are presented in Table 9.13. The level flyover and takeoff analyses are also accompanied by a tabulation of results from four previous reports (Tables 9.12 and 9.14).

Discussion - In the case of takeoff data (Table 9.11) one observes a propagation constant of 20, a value in good agreement with previous results. This value suggests that either little (to moderate) absorption takes place over the propagation path or that the source frequency content is dominated by low frequency components, (relatively unaffected by absorption).

In the case of level flyover data (Table 9.13), one observes a value less than 20. This result is somewhat anomolous suggesting the possibility of changes in absorption (or source characteristly) between the 500 and 1000 foot test series. Given the extremely small variation in noise levels within each test series one can speculate that source characteristics were constant while the rate of absorption changed. In any event one can assume that a rather low value propagation constant (K=20) would be appropriate for the AStar. This is consistent with the result acquired

for the TwinStar (Ref. 13). This characteristic is likely associated with a combination of dominant low frequency source content and low test day atmospheric absorption. Using meteorlogical data contained in the appendices of this report along with reference , the reader can further explore this topic.

Table 9.15 provides a brief examination of propagation for the EPNL acoustical metric, used in noise certification. Calculations show a constant of approximately 12. The propagation constant is somewhat below the mean value (16.8) observed for a set of six helicopters, the results of which are summarized in Table 9.16 (also see Refs. 10, 11, 12, 13). The reader may consider computing propagation constants for other acoustical metrics as the need arises.

TABLE 9.9

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: ICAO TAKEOFF

MIC. 5-4

EVENT NO.	KP(AL)	KP(SEL)
E10	17.8	8.9
E11	29.5	16.4
E12	NA	NA
E13	18.4	14.7
E14	18.9	12.4
E15	19.3	10.3
E16	NA	NA
E17	12.4	6.7
AVERAGE	19.4	11.6
STD. DEV	5.59	3.64
90% C.I.	4.60	2.99

TABLE 9.10

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: STANDARD TAKEO

MIC. 5-4

EVENT NO.	KP(AL)	KP(SEL)
649	20.6	10.1
650	NA	NA
651	21.3	13.5
652	21.5	12.3
653	18.7	12.5
654	21	11.5
AVERAGE	20.6	12
STD. DEV	1.14	1.28
90% C.I.	1.08	1.22

Table 9.11

Summary Table of Propagation Constants for Two Takeoff Operations

ICAO Takeoff	19.4
Standard Takeoff	20.6
Average	20

Table 9.12

Summary Table for Takeoff Operation--AL Metric

Helicopter	Propagation Constant (K)
Bell 222	NA
Aerospatiale Dauphin 2	20.06
Hughes 500D	21.15
Aerospatiale TwinStar	24.4
Aerospatiale AStar	20
Average	21.40

TABLE 9.13

ASTAR

LEVEL FLYOVER PROPAGATION--AL

OPERATION		MIC 5	MIC 1	MIC 4	AL WEIGHTED AVERAGE
	N=	6	6	6	
500' (0.9Vh)	AVG AL=	75.3	75.6	74.8	75.23
	STD DEV=	.3	1	.6	
	N=	4	4	4	
1000' (0.9Vh)	AVC AL=	69.9	70	69.8	69.90
	STD DEV=	.9	.7	1.7	

K= ΔdB / LOG(1072.9 / 577.69) ΔdB= 5.33

K= 5.33 / .2841664

K= 18.77

TABLE 9.14

SUMMARY FOR LEVEL FLYOVER OPERATION

AL METRIC

HELICOPTER	PROPAGATION CONSTANT (K)
BELL 222	21.08
AEROSPATIALE DAUPHIN 2	21.40
HUGHES 500D	20.81
AEROSPATIALE TWINSTAR	20.19
AEROSPATIALE ASTAR	18.77

AVERAGE = 20.45

TABLE 9.15

ASTAR

LEVEL FLYOVER PROPAGATION--EPNL

OPERATION		MIC 5	MIC 1	MIC 4	EPNL WEIGHTED AVERAGE
	N=	6	6	6	
500' (0.9Vh)	AVG EPNL=	86.4	86.5	85.5	86.13
	STD DEV=	.3	.7	.4	
	N=	NA	4	4	
1000' (0.9Vh)	AVG EPNL=	NA	82	82	82.40*
	STD DEV=	NA	.2	.6	

K= ΔdB / LOG(1072.9 / 557.69) ΔdB= 3.73

K= 3.73 / .2841664

K= 13.14

* CALCULATED FROM SITES 1 AND 4

TABLE 9.16

SUMMARY TABLE FOR EPNL

HELICOPTER	PROPAGATION CONSTANT (K)
BELL 222	14.33
AEROSPATIALE DAUPHIN 2	18.67
HUGHES 500D	14.80
AEROSPATIALE TWINSTAR	13.84
AEROSPATIALE ASTAR	13.14

AVERAGE = 14.96

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APPENDIX A

Magnetic Recording Acoustical Data and Duration Factors for Flight Operations

This appendix contains magnetic recording acoustical data acquired during flight operations. A detailed discussion is provided in Section 6.1 which describes the data reduction and processing procedures. Helpful cross references include measurement location layout, Figure 3.3; measurement equipment schematic, Figure 5.4; and measurement deployment plan, Figure 5.7. Tables A.a and A.b which follow below provide the reader with a guide to the structure of the appendix and the definition of terms used herein.

TABLE A.a

The key to the table numbering system is as follows:

Table No. A. 1-1. 1

- A. — Appendix No.
- 1-1. — Helicopter No. & Microphone Location
- 1 — Page No. of Group

Microphone No.	1	centerline-center
	1G	centerline-center(flush)
	2	sideline 492 feet (150m) south
	3	sideline 492 feet (150m) north
	4	centerline 492 feet (150m) west
	5	centerline 617 feet (188m) east

TABLE A.b

Definitions

A brief synopsis of Appendix A data column headings is presented.

EV	Event Number
SEL	Sound Exposure Level, the total sound energy measured within the period determined by the 10 dB down duration of the A-weighted time history. Reference duration, 1-second.
ALm	A-weighted Sound Level(maximum)
SEL-ALm	Duration Correction Factor
K(A)	A-weighted duration constant where: $K(A) = (SEL\text{-}ALm) / (\text{Log } DUR(A))$
Q	Time History Shape Factor, where: $Q = (10^{0.1(SEL\text{-}ALm)} / (DUR(A))$
EPNL	Effective Perceived Noise Level
PNLm	Perceived Noise Level(maximum)
PNLTm	Tone Corrected Perceived Noise Level(maximum)
K(P)	Constant used to obtain the Duration Correction for EPNL, where: $K(P) = (EPNL\text{-}PNLTm + 10) / (\text{Log } DUR(P))$
OASPLm	Overall Sound Pressure Level(maximum)
DUR(A)	The 10 dB down Duration Time for the A-weighted time history
DUR(P)	The 10 dB down Duration Time for the PNLT time history
TC	Tone Correction calculated at PNLTm

Each set of data is headed by the site number, microphone location and test date. The target reference condtions are specified above each data subset.

TABLE NO. A.3-1.1

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

DOT/TSC
3/28/84

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 1 CENTERLINE - CENTER JUNE 8,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
TAKEOFF -- TARGET IAS 63 MPH (ICAO)													
E11	84.2	72.6	11.6	7.9	0.5	87.2	84.3	86.6	7.7	78.5	29.5	24.0	2.3
E12	83.0	73.7	9.3	6.9	0.4	86.7	86.1	88.2	6.7	80.2	22.0	18.5	2.3
E13	83.4	74.3	9.1	7.0	0.4	87.1	86.1	88.2	7.0	80.4	20.5	18.5	2.1
E15	83.2	73.3	9.9	6.9	0.4	86.7	86.2	88.3	6.4	80.4	27.5	21.0	2.1
E16	82.9	72.4	10.5	7.5	0.4	86.7	84.4	86.8	7.1	79.0	25.5	25.0	2.6
E17	84.3	75.2	9.1	6.9	0.4	87.4	86.7	88.7	6.7	79.8	21.0	19.5	2.0
Avg.	83.5	73.6	9.9	7.2	0.4	87.0	85.6	87.8	6.9	79.7	24.3	21.1	2.2
Std Dv	0.6	1.0	1.0	0.4	0.0	0.3	1.0	0.9	0.4	0.8	3.7	2.8	0.2
90% CI	0.5	0.9	0.8	0.3	0.0	0.2	0.8	0.7	0.4	0.6	3.1	2.3	0.2
6 DEGREE APPROACH -- TARGET IAS 63 MPH (ICAO)													
F1	91.5	83.1	8.5	7.5	0.5	94.5	95.3	96.6	7.2	91.1	13.5	12.5	1.3
F2	91.6	83.4	8.2	7.1	0.5	94.4	94.9	95.8	7.5	90.3	14.0	14.0	0.9
F3	91.9	82.5	9.3	8.0	0.6	94.4	94.4	95.4	7.8	90.6	14.5	14.0	1.0
F4	91.7	84.0	7.8	6.7	0.4	94.4	96.0	96.9	6.7	92.3	14.5	13.5	0.9
F5	91.3	82.5	8.8	7.5	0.5	94.0	95.2	96.0	7.0	90.6	15.0	14.0	0.9
F6	91.6	82.6	9.0	7.5	0.5	94.2	94.5	95.4	7.4	91.1	16.0	15.5	1.2
F8	90.4	81.7	8.7	7.3	0.5	92.9	92.5	93.3	8.1	87.4	15.5	15.5	0.9
F9	91.2	82.5	8.6	7.4	0.5	93.7	94.4	95.4	7.4	90.0	14.5	13.0	1.1
Avg.	91.4	82.8	8.6	7.4	0.5	94.1	94.7	95.6	7.4	90.5	14.7	14.0	1.0
Std Dv	0.3	0.7	0.5	0.4	0.1	0.5	1.0	1.1	0.4	1.4	0.8	1.1	0.2
90% CI	0.3	0.5	0.3	0.3	0.0	0.4	0.7	0.7	0.3	0.9	0.5	0.7	0.1

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED
FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.3-1.2

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
3/28/84

SITE: 1 CENTERLINE - CENTER JUNE 8,1983

500 FT. FLYOVER -- TARGET IAS 143 MPH

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
N41	84.1	77.0	7.1	6.9	0.5	87.2	88.6	90.0	7.1	85.9	10.5	10.5	1.2
N42	84.0	76.4	7.6	7.1	0.5	87.0	87.8	89.0	7.2	85.0	12.0	13.0	1.2
N43	85.1	77.6	7.5	7.2	0.5	88.4	90.0	91.5	6.7	87.6	11.0	10.5	1.5
N44	84.1	76.4	7.7	6.8	0.4	87.2	87.9	89.2	7.1	85.9	13.5	13.5	1.2
Avg.	84.3	76.8	7.5	7.0	0.5	87.4	88.6	89.9	7.0	86.1	11.7	11.9	1.3
Std Dv	0.5	0.6	0.3	0.2	0.0	0.6	1.0	1.1	0.2	1.1	1.3	1.6	0.2
90% CI	0.6	0.7	0.4	0.2	0.0	0.7	1.2	1.3	0.2	1.3	1.6	1.9	0.2

500 FT. FLYOVER -- TARGET IAS 130.5 MPH

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
A22	82.9	75.3	7.6	7.1	0.5	85.9	86.9	88.4	7.0	83.7	12.0	12.0	1.5
A23	82.6	76.0	6.6	5.8	0.3	85.8	87.8	89.0	6.0	83.7	13.5	13.5	1.1
A24	83.5	76.2	7.3	6.6	0.4	86.8	88.2	89.6	6.7	84.9	13.0	12.0	1.7
A25	83.5	75.7	7.8	6.7	0.4	86.8	87.6	88.7	6.5	83.9	14.5	17.5	1.1
A26	84.0	76.7	7.3	6.3	0.4	87.5	88.6	90.1	6.5	84.6	14.0	13.5	1.7
A27	83.0	73.9	9.1	7.0	0.4	86.1	85.8	87.0	7.0	83.0	19.5	20.0	1.2
Avg.	83.2	75.6	7.6	6.6	0.4	86.5	87.5	88.8	6.6	84.0	14.4	14.7	1.4
Std Dv	0.5	1.0	0.8	0.5	0.0	0.7	1.0	1.1	0.4	0.7	2.6	3.3	0.3
90% CI	0.4	0.8	0.7	0.4	0.0	0.5	0.8	0.9	0.3	0.6	2.2	2.7	0.2

500 FT. FLYOVER -- TARGET IAS 116 MPH

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
B28	81.9	75.5	6.4	5.4	0.3	85.4	87.5	89.1	5.6	82.1	15.5	13.0	1.6
B29				NO DATA									
B30	82.1	74.6	7.6	6.5	0.4	85.4	86.4	88.2	6.3	81.8	14.5	13.5	1.8
B31	81.7	73.0	8.7	7.5	0.5	85.0	85.3	86.9	7.1	80.6	14.5	14.0	1.5
Avg.	81.9	74.3	7.6	6.5	0.4	85.2	86.4	88.1	6.4	81.5	14.8	13.5	1.6
Std Dv	0.2	1.3	1.1	1.0	0.1	0.2	1.1	1.1	0.7	0.8	0.6	0.5	0.2
90% CI	0.4	2.1	1.9	1.8	0.2	0.4	1.8	1.9	1.2	1.3	1.0	0.8	0.3

500 FT. FLYOVER -- TARGET IAS 101.5 MPH

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
C32	82.4	73.4	9.0	7.2	0.4	85.7	85.3	88.0	6.4	80.2	18.0	16.0	2.8
C33	83.1	76.0	7.1	6.5	0.4	86.0	87.7	88.6	6.8	82.1	12.0	12.0	0.9
C34	82.6	74.4	8.2	6.7	0.4	85.9	86.2	87.4	6.9	80.7	17.0	17.0	1.2
C35	82.3	74.0	8.2	6.6	0.4	85.9	86.2	87.0	7.0	81.1	17.5	18.5	1.9
C36	82.7	73.6	9.1	7.5	0.5	85.8	86.0	86.9	7.3	82.6	16.0	16.5	0.9
Avg.	82.6	74.3	8.3	6.9	0.4	85.8	86.3	87.6	6.9	81.3	16.1	16.0	1.5
Std Dv	0.3	1.0	0.8	0.4	0.1	0.1	0.9	0.7	0.3	1.0	2.4	2.4	0.8
90% CI	0.3	1.0	0.8	0.4	0.0	0.1	0.9	0.7	0.3	0.9	2.3	2.3	0.8

500 FT. FLYOVER -- TARGET IAS 86 MPH

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
M45	83.9	75.1	8.7	6.1	0.3	86.8	87.4	88.5	6.8	82.1	27.0	16.5	1.1
M46	82.4	74.4	8.0	6.5	0.4	85.9	86.4	87.7	6.5	79.8	17.5	17.5	1.4
M47	81.9	73.2	8.8	7.4	0.5	85.1	85.2	86.5	7.3	80.1	15.5	15.0	1.3
M48	82.3	73.4	8.9	7.2	0.5	85.4	85.1	86.2	7.5	80.2	17.0	17.0	1.1
Avg.	82.6	74.0	8.6	6.8	0.4	85.8	86.0	87.2	7.0	80.6	19.2	16.5	1.2
Std Dv	0.9	0.9	0.4	0.6	0.1	0.7	1.1	1.1	0.4	1.1	5.2	1.1	0.1
90% CI	1.0	1.1	0.5	0.7	0.1	0.9	1.3	1.3	0.5	1.3	6.2	1.3	0.2

TABLE NO. A.3-1.3

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

DOT/TSC
3/28/84

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 1 CENTERLINE - CENTER JUNE 8,1983

EV	SEL	ALm	SEL-ALm	K(A)	θ	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
1000 FT. FLYOVER -- TARGET IAS 130.5 MPH													
D37	79.8	71.0	8.9	6.6	0.3	82.9	82.7	84.4	6.8	80.1	22.5	18.0	1.7
D38	80.5	70.1	10.3	7.5	0.4	83.0	81.6	82.9	7.4	78.0	24.0	24.0	1.3
D39	80.0	69.7	10.3	7.3	0.4	82.7	81.4	82.4	7.4	79.6	26.0	25.5	1.0
D40	79.9	69.3	10.5	7.5	0.4	82.5	80.6	81.9	7.4	77.7	26.0	27.0	1.3
Avg.	80.0	70.0	10.0	7.2	0.4	82.8	81.6	82.9	7.2	78.8	24.6	23.6	1.3
Std Dv	0.3	0.7	0.8	0.4	0.0	0.2	0.8	1.1	0.3	1.2	1.7	3.9	0.3
90% CI	0.3	0.8	0.9	0.5	0.1	0.3	1.0	1.2	0.3	1.4	2.0	4.6	0.3
TAKEOFF -- TARGET IAS 63 MPH (MULTI-SEG SEE TEXT)													
G49	85.8	77.0	8.8	7.1	0.4	88.5	88.4	90.2	6.8	81.0	17.5	16.5	1.9
G50	85.9	76.4	9.5	7.4	0.5	88.6	87.6	89.8	6.9	80.1	19.5	19.0	2.2
G51	84.5	74.7	9.8	7.6	0.5	87.2	85.9	87.7	7.4	79.1	19.5	19.0	2.0
G52	85.8	76.7	9.1	7.2	0.5	88.3	87.8	89.4	7.4	80.2	18.0	15.5	1.7
G53	84.8	75.8	9.0	7.4	0.5	87.4	86.8	88.7	7.1	80.4	17.0	17.0	1.9
G54	84.9	76.3	8.6	7.3	0.5	87.6	87.3	88.8	7.5	80.8	15.0	15.0	2.0
Avg.	85.3	76.1	9.1	7.3	0.5	87.9	87.3	89.1	7.2	80.3	17.7	17.0	2.0
Std Dv	0.6	0.8	0.4	0.2	0.0	0.6	0.9	0.9	0.3	0.7	1.7	1.7	0.2
90% CI	0.5	0.7	0.4	0.1	0.0	0.5	0.7	0.7	0.2	0.6	1.4	1.4	0.2
9 DEGREE APPROACH -- TARGET IAS 63 MPH													
H18	90.5	83.0	7.4	7.0	0.5	93.1	94.8	95.8	7.1	90.8	11.5	11.0	1.0
H19	87.4	79.1	8.3	6.8	0.4	89.8	91.2	91.7	6.7	85.9	16.5	16.0	0.5
H20	88.9	81.3	7.6	6.6	0.4	91.4	93.1	94.1	6.5	89.0	14.5	13.5	1.0
H21	86.7	79.1	7.6	6.3	0.4	89.5	91.4	92.1	6.9	86.4	16.5	11.5	0.6
Avg.	88.4	80.6	7.7	6.7	0.4	91.0	92.6	93.4	6.8	88.0	14.7	13.0	0.8
Std Dv	1.7	1.9	0.4	0.3	0.1	1.7	1.7	1.9	0.3	2.3	2.4	2.3	0.2
90% CI	1.9	2.2	0.4	0.4	0.1	2.0	2.0	2.2	0.3	2.7	2.8	2.7	0.3

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED
FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.3-16

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

DOT/TSC
3/29/84

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 16 CENTERLINE-CENTER (FLUSH) JUNE 8,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC

---------- NO DATA ----------

TABLE NO. A.3-2.1

AEROSPATIALE AS-350D HELICOPTER (ASTAR) DOT/TSC 3/28/84

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 2 SIDELINE - 150 M. SOUTH JUNE 8,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
TAKEOFF -- TARGET IAS 63 MPH (ICAO)													
E11	85.6	74.3	11.3	7.9	0.5	-	85.3	87.6	-	79.4	26.5	-	2.4
E12				NO DATA									
E13	85.9	76.3	9.6	7.2	0.4	-	87.0	89.0	-	81.8	21.5	-	2.0
E15	84.8	73.8	11.0	7.6	0.5	87.2	85.4	87.5	7.0	81.4	27.5	24.5	2.1
E16	85.2	73.5	11.6	7.9	0.5	87.5	84.4	87.0	7.4	80.0	29.5	26.5	2.6
E17	84.7	73.6	11.2	7.5	0.4	87.3	84.9	87.7	6.7	80.2	31.0	27.0	2.8
Avg.	85.2	74.3	10.9	7.6	0.5	87.3	85.4	87.8	7.0	80.5	27.2	26.0	2.4
Std Dv	0.5	1.1	0.8	0.3	0.0	0.2	1.0	0.7	0.4	1.0	3.6	1.3	0.3
90% CI	0.5	1.1	0.7	0.3	0.0	0.3	0.9	0.7	0.6	0.9	3.5	2.2	0.3
6 DEGREE APPROACH -- TARGET IAS 63 MPH (ICAO)													
F1	84.5	74.5	10.0	6.7	0.3	87.3	86.7	88.3	7.0	81.7	31.0	19.0	1.6
F2	83.8	73.4	10.4	7.3	0.4	86.9	85.7	87.0	7.2	81.2	26.5	23.0	1.3
F3	84.1	73.6	10.5	7.2	0.4	86.9	85.9	87.2	7.2	80.9	28.5	22.0	1.4
F4				NO DATA									
F5	83.7	74.0	9.7	7.1	0.4	86.9	86.4	87.8	6.7	81.3	23.5	22.5	1.4
F6	83.2	72.7	10.5	8.1	0.6	-	85.0	86.4	-	82.6	19.5	-	1.4
F8	84.6	74.2	10.4	7.2	0.4	87.4	86.0	87.6	7.0	80.8	28.5	25.0	1.6
F9	83.7	73.5	10.2	7.1	0.4	86.8	85.7	86.9	6.9	82.1	28.0	27.0	1.2
Avg.	84.0	73.7	10.3	7.2	0.4	87.0	85.9	87.3	7.0	81.5	26.5	23.1	1.4
Std Dv	0.5	0.6	0.3	0.4	0.1	0.3	0.5	0.6	0.2	0.6	3.8	2.7	0.1
90% CI	0.4	0.4	0.2	0.3	0.1	0.2	0.4	0.5	0.2	0.5	2.8	2.2	0.1

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED
FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.3-2.2

AEROSPATIALE AS-3500 HELICOPTER (ASTAR)

DOT/TSC
3/28/84

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 2 SIDELINE - 150 M. SOUTH JUNE 8,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
500 FT. FLYOVER -- TARGET IAS 143 MPH													
N41	83.2	75.6	7.7	6.9	0.4	85.8	86.6	87.9	6.7	86.4	13.0	15.0	1.8
N42	82.2	74.0	8.2	6.9	0.4	85.2	85.1	86.7	6.5	86.5	15.5	20.0	1.6
N43	84.8	77.1	7.7	6.9	0.5	87.3	89.0	90.1	6.7	88.5	13.0	12.0	1.5
N44	83.6	74.8	8.8	7.1	0.4	85.6	85.4	86.2	7.4	87.1	17.0	18.5	0.9
Avg.	83.5	75.4	8.1	7.0	0.4	86.0	86.5	87.7	6.8	87.1	14.6	16.4	1.4
Std Dv	1.1	1.3	0.5	0.1	0.0	0.9	1.8	1.7	0.4	1.0	2.0	3.6	0.4
90% CI	1.3	1.6	0.6	0.1	0.0	1.1	2.1	2.0	0.5	1.1	2.3	4.2	0.5
500 FT. FLYOVER -- TARGET IAS 130.5 MPH													
A22	83.3	75.6	7.7	6.7	0.4	85.6	87.0	88.2	6.6	84.5	14.0	13.5	1.3
A23	81.9	74.1	7.8	6.8	0.4	84.4	84.5	85.4	6.4	83.9	14.0	26.0	0.9
A24	83.7	76.3	7.3	6.2	0.4	86.0	87.2	88.4	6.5	84.7	15.0	15.0	1.1
A25	81.4	72.7	8.7	6.8	0.4	83.5	83.1	84.2	7.2	83.9	19.0	20.0	1.3
A26	83.2	75.3	7.9	7.0	0.5	85.7	86.8	88.5	6.5	84.1	13.5	12.5	1.7
A27	81.6	74.0	7.5	6.4	0.4	83.8	84.6	85.9	6.6	83.8	15.0	15.5	1.4
Avg.	82.5	74.7	7.8	6.7	0.4	84.8	85.5	86.8	6.6	84.1	15.1	17.1	1.3
Std Dv	1.0	1.3	0.5	0.3	0.0	1.1	1.7	1.8	0.3	0.4	2.0	5.1	0.3
90% CI	0.8	1.1	0.4	0.2	0.0	0.9	1.4	1.5	0.2	0.3	1.7	4.2	0.2
500 FT. FLYOVER -- TARGET IAS 116 MPH													
B28	82.3	74.2	8.1	7.0	0.4	84.6	85.3	86.5	6.9	81.8	14.5	15.0	1.2
B29	81.7	73.0	8.6	7.0	0.4	83.7	83.9	84.6	7.0	80.9	17.5	20.0	0.7
B30	82.6	74.6	8.0	6.7	0.4	84.8	85.6	86.9	6.6	82.6	15.5	15.5	1.3
Avg.	82.2	74.0	8.2	6.9	0.4	84.4	84.9	86.0	6.8	81.8	15.8	16.8	1.1
Std Dv	0.5	0.8	0.4	0.2	0.0	0.5	0.9	1.2	0.2	0.8	1.5	2.8	0.3
90% CI	0.8	1.4	0.6	0.3	0.0	0.9	1.5	2.0	0.3	1.4	2.6	4.6	0.5
500 FT. FLYOVER -- TARGET IAS 101.5 MPH													
C32	81.1	72.9	8.2	6.9	0.4	83.4	84.0	85.3	6.8	79.7	15.5	16.0	1.3
C33				NO DATA									
C34	80.4	71.4	9.0	7.0	0.4	82.6	82.6	83.6	7.0	79.7	19.5	19.0	1.0
C35	82.1	73.1	8.9	7.1	0.4	-	84.7	85.9	-	80.8	18.0	-	1.2
C36	80.2	71.1	9.1	6.9	0.4	82.1	82.0	83.1	6.8	79.9	21.0	21.0	1.1
Avg.	80.9	72.1	8.8	7.0	0.4	82.7	83.3	84.5	6.8	80.0	18.5	18.7	1.1
Std Dv	0.8	1.0	0.4	0.1	0.0	0.7	1.2	1.3	0.1	0.5	2.3	2.5	0.1
90% CI	1.0	1.2	0.5	0.1	0.0	1.2	1.4	1.6	0.2	0.6	2.8	4.2	0.1
500 FT. FLYOVER -- TARGET IAS 86 MPH													
M45	80.0	73.1	6.8	5.9	0.3	-	83.5	85.3	-	79.8	14.0	-	1.8
M46	81.3	71.0	10.3	7.6	0.5	83.6	82.0	83.7	7.4	79.1	22.5	22.0	1.9
M47	81.6	72.6	8.9	7.0	0.4	83.9	83.1	84.9	7.1	80.4	18.5	18.0	1.8
M48	80.7	70.6	10.1	6.9	0.3	82.8	82.1	83.3	7.0	79.1	29.5	22.0	1.2
Avg.	80.9	71.8	9.0	6.9	0.4	83.4	82.7	84.3	7.2	79.6	21.1	20.7	1.7
Std Dv	0.7	1.2	1.6	0.7	0.1	0.6	0.8	1.0	0.2	0.6	6.6	2.3	0.3
90% CI	0.8	1.5	1.9	0.8	0.1	1.0	0.9	1.1	0.3	0.7	7.7	3.9	0.4

TABLE NO. A.3-2.3

AEROSPATIALE AS-3500 HELICOPTER (ASTAR)

DOT/TSC
3/29/84

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 2 SIDELINE - 150 M. SOUTH JUNE 8,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
1000 FT. FLYOVER -- TARGET IAS 130.5 MPH													
D37	79.1	69.2	9.8	6.9	0.4	81.2	80.7	82.3	7.0	79.6	27.0	18.5	1.6
D38	79.6	69.0	10.7	7.3	0.4	81.5	79.5	80.4	7.6	79.9	29.0	29.5	0.9
D39	78.8	68.8	10.0	7.4	0.4	81.6	81.1	82.7	6.7	79.7	22.5	21.0	1.3
D40	79.5	68.7	10.8	7.5	0.4	81.3	79.1	80.2	7.6	79.6	27.5	28.5	1.4
Avg.	79.2	68.9	10.3	7.3	0.4	81.4	80.1	81.4	7.2	79.7	26.5	24.4	1.3
Std Dv	0.4	0.2	0.5	0.3	0.0	0.2	1.0	1.3	0.4	0.1	2.8	5.5	0.3
90% CI	0.5	0.3	0.5	0.3	0.0	0.2	1.1	1.5	0.5	0.2	3.3	6.4	0.4
TAKEOFF -- TARGET IAS 63 MPH (MULTI-SEG SEE TEXT)													
G49	84.8	74.4	10.4	7.8	0.5	-	85.3	86.9	-	81.1	21.5	-	1.6
G50	84.8	73.5	11.3	7.6	0.4	87.1	84.6	87.1	6.8	80.3	30.5	29.5	2.5
G51	85.0	74.8	10.2	7.3	0.4	87.2	85.3	87.8	7.0	81.1	24.5	22.5	2.6
G52	84.5	73.7	10.7	7.8	0.5	86.9	85.1	87.7	6.9	80.8	23.5	21.5	2.6
G53	83.9	72.9	11.0	7.8	0.5	86.0	84.1	86.2	7.2	79.6	25.0	23.0	2.1
G54	84.4	74.1	10.3	7.6	0.5	86.8	85.3	87.5	7.1	80.6	22.0	20.0	2.3
Avg.	84.6	73.9	10.6	7.7	0.5	86.8	84.9	87.2	7.0	80.6	24.5	23.3	2.3
Std Dv	0.4	0.7	0.4	0.2	0.0	0.5	0.5	0.6	0.2	0.6	3.2	3.7	0.4
90% CI	0.3	0.6	0.4	0.2	0.0	0.5	0.4	0.5	0.2	0.5	2.7	3.5	0.3
9 DEGREE APPROACH -- TARGET IAS 63 MPH													
H18	83.2	71.9	11.3	7.5	0.4	86.0	84.6	86.1	7.1	81.8	32.0	24.5	1.5
H19	82.9	72.6	10.3	7.2	0.4	85.3	83.6	84.8	7.3	82.0	27.0	27.0	1.2
H20	82.8	72.4	10.4	7.7	0.5	85.4	84.4	85.9	7.4	81.7	22.5	19.5	1.4
H21	82.8	73.5	9.4	6.4	0.3	85.2	84.3	85.7	6.5	81.0	29.0	28.0	1.4
Avg.	82.9	72.6	10.3	7.2	0.4	85.4	84.2	85.6	7.1	81.6	27.6	24.7	1.4
Std Dv	0.2	0.7	0.8	0.6	0.1	0.4	0.4	0.6	0.4	0.5	4.0	3.8	0.1
90% CI	0.2	0.8	0.9	0.7	0.1	0.4	0.5	0.7	0.5	0.5	4.7	4.5	0.2

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED
FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.3-3.1

AEROSPATIALE AS-3500 HELICOPTER (ASTAR)

DOT/TSC
3/29/84

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 3 SIDELINE - 150 M. NORTH JUNE 8,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
TAKEOFF -- TARGET IAS 63 MPH (ICAO)													
E11	84.8	73.5	11.2	8.0	0.5	87.6	84.8	87.2	7.9	79.1	25.5	21.0	2.5
E12	84.5	74.6	10.0	7.7	0.5	86.1	84.4	86.1	7.7	79.3	20.0	20.0	1.8
E13	85.2	76.4	8.7	6.6	0.3	87.2	86.4	88.9	6.8	80.4	21.5	16.5	2.5
E15	84.8	75.8	9.0	7.1	0.4	86.8	85.5	88.1	6.9	79.6	18.5	18.0	2.6
E16	85.4	75.2	10.1	7.2	0.4	87.6	84.9	87.6	7.3	79.2	25.5	23.0	2.7
E17	84.4	74.1	10.2	7.0	0.4	86.7	84.6	87.4	7.3	79.9	29.5	18.5	2.8
Avg.	84.8	75.0	9.9	7.2	0.4	87.0	85.1	87.5	7.3	79.6	23.4	19.5	2.5
Std Dv	0.4	1.1	0.9	0.5	0.1	0.6	0.7	0.9	0.4	0.5	4.1	2.3	0.4
90% CI	0.3	0.9	0.7	0.4	0.1	0.5	0.6	0.8	0.3	0.4	3.4	1.9	0.3
6 DEGREE APPROACH -- TARGET IAS 63 MPH (ICAO)													
F1	87.0	78.9	8.1	7.0	0.4	89.7	89.5	91.3	7.3	85.7	14.5	14.5	1.8
F2	85.5	75.1	10.4	7.3	0.4	87.8	86.1	88.4	6.9	83.6	26.0	22.5	2.3
F3	85.2	76.1	9.0	7.1	0.4	88.0	87.6	89.8	6.6	84.2	19.0	17.0	2.2
F4	85.7	76.4	9.3	7.0	0.4	88.2	87.5	89.2	7.3	84.8	21.0	17.5	1.7
F5	85.9	76.5	9.4	7.3	0.5	88.3	87.7	89.7	7.0	84.8	19.0	17.0	2.0
F6	85.6	77.6	8.0	6.7	0.4	88.2	87.9	89.8	7.0	84.1	16.0	15.5	2.2
F8	85.6	77.5	8.0	5.9	0.3	88.1	87.6	88.9	6.8	84.0	23.0	23.5	1.2
F9	86.3	76.2	10.1	7.1	0.4	89.0	87.6	89.2	6.9	84.5	26.5	26.0	1.6
Avg.	85.8	76.8	9.0	6.9	0.4	88.4	87.7	89.5	7.0	84.5	20.6	19.2	1.9
Std Dv	0.6	1.2	0.9	0.5	0.1	0.6	0.9	0.9	0.2	0.6	4.4	4.2	0.4
90% CI	0.4	0.8	0.6	0.3	0.0	0.4	0.6	0.6	0.2	0.4	2.9	2.8	0.2

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED
FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.3-3.2

AEROSPATIALE AS-3500 HELICOPTER (ASTAR)

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
3/29/84

SITE: 3 SIDELINE - 150 M. NORTH JUNE 8,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
500 FT. FLYOVER -- TARGET IAS 143 MPH													
N41		----------		NO DATA		----------							
N42	84.3	75.9	8.4	7.1	0.5	86.5	86.7	88.0	7.2	85.4	15.0	15.0	1.3
N43	83.1	75.8	7.4	6.7	0.4	85.3	86.3	87.1	6.8	86.1	12.5	16.0	0.9
N44	84.3	76.2	8.1	6.8	0.4	86.7	87.0	88.3	7.0	86.0	15.5	16.0	1.3
Avg.	83.9	76.0	8.0	6.9	0.4	86.2	86.7	87.8	7.0	85.8	14.3	15.7	1.2
Std Dv	0.7	0.2	0.5	0.2	0.0	0.7	0.4	0.6	0.2	0.4	1.6	0.6	0.2
90% CI	1.1	0.4	0.9	0.4	0.0	1.2	0.6	1.0	0.3	0.7	2.7	1.0	0.4
500 FT. FLYOVER -- TARGET IAS 130.5 MPH													
A22	81.4	74.1	7.3	6.3	0.4	83.7	84.7	86.0	6.5	81.8	14.5	15.0	1.5
A23	83.0	74.5	8.4	7.4	0.5	85.7	86.9	87.9	6.9	85.4	14.0	13.5	0.9
A24	81.9	74.3	7.5	6.7	0.4	83.9	85.0	86.2	6.8	83.3	13.5	13.5	1.1
A25	82.7	74.3	8.4	7.2	0.5	85.0	85.1	86.4	7.4	83.7	15.0	14.5	1.6
A26		----------		NO DATA		----------							
A27	82.7	74.7	8.0	6.6	0.4	85.3	85.5	87.2	6.4	82.6	16.0	19.0	1.7
Avg.	82.3	74.4	7.9	6.8	0.4	84.7	85.5	86.7	6.8	83.4	14.6	15.1	1.4
Std Dv	0.7	0.3	0.5	0.4	0.1	0.9	0.7	0.8	0.4	1.4	1.0	2.3	0.3
90% CI	0.6	0.2	0.5	0.4	0.0	0.8	0.8	0.7	0.4	1.3	0.9	2.2	0.3
500 FT. FLYOVER -- TARGET IAS 116 MPH													
B28	80.3	72.3	8.0	6.9	0.4	82.9	83.0	84.2	6.5	79.4	14.5	21.5	1.2
B29	82.8	74.3	8.5	7.0	0.4	85.2	84.8	86.5	7.0	81.1	16.5	17.5	1.6
B30	81.5	72.9	8.7	7.4	0.5	83.2	83.8	84.4	7.4	79.7	15.0	15.5	0.6
B31	82.7	74.4	8.4	7.0	0.4	85.1	84.9	86.7	7.0	81.3	15.5	16.0	1.7
Avg.	81.8	73.4	8.4	7.1	0.4	84.1	84.2	85.4	7.0	80.4	15.4	17.6	1.3
Std Dv	1.2	1.1	0.3	0.2	0.0	1.2	0.9	1.3	0.4	0.9	0.9	2.7	0.5
90% CI	1.4	1.2	0.3	0.2	0.0	1.4	1.1	1.5	0.4	1.1	1.0	3.2	0.6
500 FT. FLYOVER -- TARGET IAS 101.5 MPH													
C32	82.6	73.2	9.4	7.0	0.4	84.6	83.6	85.1	7.1	80.1	21.5	21.0	1.5
C33		----------		NO DATA		----------							
C34	81.9	72.3	9.6	7.3	0.4	84.3	83.3	84.8	7.5	81.0	20.5	19.0	1.9
C35	81.6	71.1	10.5	7.2	0.4	84.9	82.6	83.7	7.3	79.2	29.0	34.0	1.9
C36	82.0	72.8	9.1	6.8	0.4	84.5	84.1	85.3	6.8	81.5	22.5	22.0	1.3
Avg.	82.0	72.4	9.6	7.1	0.4	84.6	83.4	84.7	7.2	80.5	23.4	24.0	1.7
Std Dv	0.4	0.9	0.6	0.2	0.0	0.3	0.7	0.7	0.3	1.0	3.8	6.8	0.3
90% CI	0.5	1.1	0.7	0.3	0.0	0.3	0.8	0.9	0.3	1.2	4.5	8.0	0.3
500 FT. FLYOVER -- TARGET IAS 86 MPH													
M45	80.9	71.6	9.3	7.3	0.5	83.1	82.4	84.1	7.1	79.7	19.0	18.5	1.6
M46	82.2	72.7	9.4	7.2	0.4	84.7	83.1	85.1	7.4	81.2	20.0	19.5	2.1
M47	80.3	71.1	9.2	6.4	0.3	82.9	82.3	84.0	6.4	78.1	27.0	25.0	1.7
M48	82.4	73.0	9.4	7.4	0.5	84.8	83.4	85.6	7.3	80.1	19.0	18.5	2.2
Avg.	81.5	72.1	9.3	7.1	0.4	83.9	82.8	84.7	7.0	79.8	21.2	20.4	1.9
Std Dv	1.0	0.9	0.1	0.4	0.1	1.0	0.5	0.8	0.5	1.3	3.9	3.1	0.3
90% CI	1.2	1.1	0.1	0.5	0.1	1.2	0.6	0.9	0.6	1.5	4.5	3.7	0.3

TABLE NO. A.3-3.3

AEROSPATIALE AS-3500 HELICOPTER (ASTAR)

DOT/TSC
3/29/84

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 3 SIDELINE - 150 M. NORTH JUNE 8,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	DASPLm	DUR(A)	DUR(P)	TC
1000 FT. FLYOVER -- TARGET IAS 130.5 MPH													
D37	79.2	69.5	9.7	7.4	0.4	81.6	80.5	81.8	6.9	79.3	21.0	26.0	1.4
D38	80.7	70.0	10.7	7.4	0.4	83.1	81.6	82.9	7.1	79.9	28.0	27.0	1.3
D39	78.7	69.6	9.1	6.7	0.4	80.7	79.6	81.1	7.0	77.5	23.0	24.0	1.5
D40	80.1	69.8	10.3	7.1	0.4	82.9	80.5	81.7	7.7	79.7	28.0	28.5	1.2
Avg.	79.7	69.7	10.0	7.1	0.4	82.1	80.5	81.9	7.2	79.1	25.0	26.4	1.3
Std Dv	0.9	0.2	0.7	0.3	0.0	1.1	0.8	0.8	0.3	1.1	3.6	1.9	0.1
90% CI	1.1	0.3	0.8	0.4	0.1	1.3	1.0	0.9	0.4	1.3	4.2	2.2	0.1
TAKEOFF -- TARGET IAS 63 MPH (MULTI-SEG SEE TEXT)													
G49	85.2	75.7	9.4	7.5	0.5	87.1	86.0	88.7	7.1	79.8	18.0	15.0	2.7
G50	84.8	75.8	9.1	6.8	0.4	87.1	85.9	88.5	6.6	80.2	21.0	19.5	2.8
G51	84.2	76.4	7.8	6.1	0.3	86.3	86.1	88.9	6.2	80.6	19.0	15.5	2.7
G52	84.2	75.7	8.5	6.7	0.4	86.4	86.1	88.9	6.2	80.2	18.0	16.0	2.8
G53	83.9	75.6	8.3	6.7	0.4	86.0	85.3	87.6	6.6	79.3	17.0	18.5	2.4
G54	84.1	75.1	9.0	6.9	0.4	86.1	85.3	87.9	6.5	78.9	20.0	18.5	2.6
Avg.	84.4	75.7	8.7	6.8	0.4	86.5	85.8	88.4	6.5	79.8	18.8	17.2	2.7
Std Dv	0.5	0.4	0.6	0.5	0.1	0.5	0.4	0.6	0.3	0.6	1.5	1.9	0.1
90% CI	0.4	0.3	0.5	0.4	0.0	0.4	0.3	0.5	0.3	0.5	1.2	1.6	0.1
9 DEGREE APPROACH -- TARGET IAS 63 MPH													
H18	86.1	77.4	8.8	7.4	0.5	88.7	88.9	90.8	6.9	85.4	15.5	14.5	1.9
H19	86.3	78.4	7.9	7.1	0.5	88.3	88.4	89.5	7.8	84.4	13.0	13.5	1.6
H20	88.4	78.8	9.7	7.8	0.5	90.4	89.5	91.3	7.4	85.8	17.5	17.0	1.8
H21	85.2	77.8	7.4	6.8	0.5	87.6	89.1	90.6	6.7	84.4	12.0	11.0	1.4
Avg.	86.5	78.1	8.4	7.3	0.5	88.7	89.0	90.6	7.2	85.0	14.5	14.0	1.7
Std Dv	1.4	0.6	1.0	0.4	0.0	1.2	0.5	0.8	0.5	0.7	2.5	2.5	0.2
90% CI	1.6	0.7	1.2	0.5	0.0	1.4	0.5	0.9	0.6	0.8	2.9	2.9	0.2

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED
FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.3-4.1

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

DOT/TSC
3/29/84

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 4 CENTERLINE - 150 M. WEST JUNE 8,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
TAKEOFF -- TARGET IAS 63 MPH (ICAO)													
E11	81.9	69.7	12.2	7.9	0.5	84.7	81.9	84.4	7.1	76.0	35.0	28.0	2.6
E12	81.6	71.6	10.0	7.1	0.4	84.7	83.6	85.8	6.7	78.3	25.5	21.0	2.2
E13	81.2	71.0	10.2	7.2	0.4	84.0	82.9	84.9	6.7	77.1	26.0	22.5	2.1
E15	81.0	70.1	11.0	7.7	0.5	84.4	82.1	84.7	7.3	77.0	26.5	22.0	2.6
E16	81.5	71.3	10.2	7.0	0.4	84.8	82.9	84.9	6.8	77.3	29.5	28.0	2.0
E17	82.2	70.8	11.4	7.9	0.5	84.8	82.2	84.5	7.7	76.6	27.5	21.5	2.3
Avg.	81.6	70.8	10.8	7.5	0.4	84.6	82.6	84.9	7.0	77.0	28.3	23.8	2.3
Std Dv	0.4	0.7	0.9	0.4	0.1	0.3	0.7	0.5	0.4	0.8	3.6	3.3	0.3
90% CI	0.4	0.6	0.7	0.4	0.0	0.3	0.6	0.4	0.3	0.6	2.9	2.7	0.2
6 DEGREE APPROACH -- TARGET IAS 63 MPH (ICAO)													
F1	91.2	81.8	9.4	7.6	0.5	93.4	93.5	94.7	7.3	89.4	17.0	16.0	1.1
F2	90.6	81.1	9.5	7.5	0.5	93.0	92.6	93.8	7.4	88.1	18.5	17.5	1.8
F3	90.1	81.0	9.1	7.4	0.5	92.4	92.9	94.1	6.9	88.6	17.0	16.0	1.2
F4	89.0	79.8	9.2	7.7	0.5	91.8	92.0	93.2	7.2	86.5	15.5	15.5	1.2
F5	90.0	80.2	9.7	7.6	0.5	92.9	92.7	93.9	7.1	88.6	19.0	18.5	1.7
F6	90.2	82.1	8.1	6.7	0.4	92.8	94.2	95.1	6.4	89.7	16.0	15.5	0.9
F8	89.1	79.4	9.8	8.1	0.6	91.8	91.6	92.6	7.7	86.9	16.0	15.5	1.1
F9	90.0	81.3	8.8	7.7	0.5	92.6	92.9	93.8	7.8	88.7	14.0	13.5	0.9
Avg.	90.0	80.8	9.2	7.5	0.5	92.6	92.8	93.9	7.2	88.3	16.6	16.0	1.2
Std Dv	0.7	1.0	0.5	0.4	0.1	0.6	0.8	0.8	0.4	1.1	1.6	1.5	0.3
90% CI	0.5	0.6	0.4	0.3	0.0	0.4	0.5	0.5	0.3	0.7	1.1	1.0	0.2

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED
FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.3-4.2

AEROSPATIALE AS-3500 HELICOPTER (ASTAR)

SUMMARY NOISE LEVEL DATA

AS MEASURED *

DOT/TSC
3/29/84

SITE: 4 CENTERLINE - 150 M. WEST JUNE 8,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
500 FT. FLYOVER -- TARGET IAS 143 MPH													
M41	83.2	75.6	7.6	6.5	0.4	85.9	87.5	88.7	6.8	84.5	14.5	11.0	1.2
M42	82.6	74.7	7.9	6.6	0.4	85.4	86.0	86.8	7.0	83.0	15.5	17.0	0.7
M43	83.2	75.9	7.3	6.9	0.5	86.3	87.9	89.4	6.5	86.2	11.5	11.5	1.5
M44	84.0	76.0	8.0	7.0	0.4	86.7	87.7	89.2	7.2	85.1	14.0	11.0	1.7
Avg.	83.2	75.6	7.7	6.7	0.4	86.1	87.3	88.5	6.9	84.7	13.9	12.6	1.3
Std Dv	0.6	0.6	0.3	0.2	0.0	0.6	0.9	1.2	0.3	1.3	1.7	2.9	0.4
90% CI	0.7	0.7	0.4	0.2	0.0	0.7	1.0	1.4	0.4	1.6	2.0	3.4	0.5
500 FT. FLYOVER -- TARGET IAS 130.5 MPH													
A22	82.2	75.7	6.5	6.5	0.4	85.4	87.2	88.6	6.8	82.6	10.0	10.0	1.4
A23	82.3	74.8	7.5	6.8	0.4	85.2	87.1	88.4	6.3	84.1	12.5	12.0	1.3
A24	82.6	74.9	7.7	7.1	0.5	85.8	87.4	89.1	6.6	83.8	12.0	10.5	1.7
A25	82.4	73.9	8.4	7.0	0.4	85.6	85.6	87.0	7.1	82.3	16.0	16.0	1.4
A26	83.0	75.0	8.0	7.2	0.5	86.1	86.9	88.1	7.4	83.0	13.0	12.0	1.3
A27	82.4	74.7	7.7	6.8	0.4	85.3	86.4	87.8	6.7	81.7	14.0	13.0	1.5
Avg.	82.5	74.8	7.6	6.9	0.5	85.5	86.8	88.2	6.8	82.9	12.9	12.2	1.4
Std Dv	0.3	0.6	0.6	0.2	0.0	0.4	0.7	0.7	0.4	0.9	2.0	2.1	0.2
90% CI	0.2	0.5	0.5	0.2	0.0	0.3	0.6	0.6	0.3	0.8	1.7	1.8	0.1
500 FT. FLYOVER -- TARGET IAS 116 MPH													
B28	81.5	73.4	8.1	7.4	0.5	84.7	85.1	86.4	7.5	81.3	12.5	13.0	1.4
B29	82.0	74.1	7.8	7.2	0.5	85.1	85.8	87.0	6.5	80.7	12.0	17.5	1.6
B30	83.1	75.2	7.9	6.6	0.4	86.2	87.6	88.7	6.4	82.7	16.0	14.5	1.3
B31	81.9	73.8	8.1	7.0	0.5	85.0	85.6	87.1	6.9	79.7	14.0	14.0	1.6
Avg.	82.1	74.1	8.0	7.1	0.5	85.2	86.0	87.3	6.8	81.1	13.6	14.7	1.5
Std Dv	0.7	0.8	0.1	0.3	0.1	0.6	1.1	1.0	0.5	1.3	1.8	1.9	0.2
90% CI	0.8	0.9	0.1	0.4	0.1	0.8	1.3	1.2	0.6	1.5	2.1	2.3	0.2
500 FT. FLYOVER -- TARGET IAS 101.5 MPH													
C32	81.2	72.8	8.4	7.2	0.5	84.2	84.7	85.7	6.8	79.2	14.5	18.0	1.0
C33	80.7	73.2	7.5	7.2	0.5	-	85.7	86.6	-	82.0	11.0	-	0.9
C34	81.2	72.2	9.0	7.0	0.4	84.6	83.7	85.0	6.8	78.9	19.5	26.0	1.3
C35	81.1	73.7	7.4	6.5	0.4	-	86.3	87.2	-	81.4	13.5	-	0.9
C36	82.3	73.7	8.6	6.8	0.4	85.3	84.7	85.7	7.6	81.0	18.0	18.5	1.3
Avg.	81.3	73.1	8.2	7.0	0.4	84.7	85.0	86.0	7.1	80.5	15.3	20.8	1.1
Std Dv	0.6	0.6	0.7	0.3	0.0	0.5	1.0	0.9	0.4	1.4	3.4	4.5	0.2
90% CI	0.5	0.6	0.7	0.3	0.0	0.9	1.0	0.8	0.7	1.3	3.3	7.6	0.2
500 FT. FLYOVER -- TARGET IAS 86 MPH													
M45	83.2	74.1	9.1	7.4	0.5	-	85.9	87.3	-	81.7	17.0	-	1.4
M46	81.4	71.8	9.6	7.3	0.4	84.3	83.4	84.8	7.2	78.4	20.5	21.0	1.4
M47	81.2	73.1	8.1	6.3	0.3	84.1	84.8	86.1	7.0	79.2	19.0	14.0	1.2
M48	81.2	72.4	8.8	7.4	0.5	84.4	84.4	86.0	7.1	79.4	15.5	15.5	2.0
Avg.	81.7	72.9	8.9	7.1	0.4	84.3	84.6	86.0	7.1	79.7	18.0	16.8	1.5
Std Dv	1.0	1.0	0.6	0.5	0.1	0.2	1.0	1.0	0.1	1.4	2.2	3.7	0.3
90% CI	1.1	1.1	0.7	0.6	0.1	0.3	1.2	1.2	0.2	1.6	2.6	6.2	0.4

TABLE NO. A.3-4.3

AEROSPATIALE AS-3500 HELICOPTER (ASTAR)

DOT/TSC
3/29/84

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 4 CENTERLINE - 150 M. WEST JUNE 8,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
1000 FT. FLYOVER -- TARGET IAS 130.5 MPH													
D37	79.9	71.9	8.1	6.5	0.4	82.7	83.0	84.3	6.9	80.0	17.5	16.5	1.3
D38	79.2	69.3	9.9	6.9	0.4	81.8	80.3	82.1	6.8	77.4	27.0	26.0	1.9
D39	79.3	70.2	9.2	7.1	0.4	82.0	81.6	83.2	6.9	78.9	19.5	19.0	1.5
D40	78.8	67.9	10.9	7.5	0.4	81.4	79.6	81.0	7.2	76.9	27.5	28.0	1.4
Avg.	79.3	69.8	9.5	7.0	0.4	82.0	81.1	82.7	6.9	78.3	22.9	22.4	1.5
Std Dv	0.5	1.7	1.2	0.4	0.0	0.6	1.5	1.4	0.2	1.4	5.1	5.5	0.3
90% CI	0.6	1.9	1.4	0.5	0.0	0.7	1.8	1.7	0.2	1.7	6.0	6.5	0.3
TAKEOFF -- TARGET IAS 63 MPH (MULTI-SEG SEE TEXT)													
G49	84.6	74.7	9.9	7.5	0.5	87.0	85.4	87.5	7.3	78.2	20.5	20.5	2.1
G50	84.2	73.9	10.3	7.8	0.5	86.6	84.6	86.3	7.8	77.8	21.0	20.5	1.8
G51	83.8	73.9	9.9	7.3	0.4	85.9	84.3	86.0	7.4	77.2	22.5	22.0	2.0
G52	84.0	74.4	9.6	7.1	0.4	-	85.3	87.1	-	77.9	23.0	-	1.8
G53	83.0	73.8	9.3	7.4	0.5	85.4	84.7	86.4	7.2	77.1	18.0	18.0	1.5
G54	83.1	73.8	9.3	7.6	0.5	85.5	84.7	86.6	7.2	77.9	17.0	17.0	2.2
Avg.	83.8	74.1	9.7	7.4	0.5	86.1	84.8	86.6	7.4	77.7	20.3	19.6	1.9
Std Dv	0.6	0.4	0.4	0.2	0.0	0.7	0.4	0.5	0.2	0.5	2.4	2.0	0.3
90% CI	0.5	0.3	0.3	0.2	0.0	0.7	0.4	0.4	0.2	0.4	2.0	1.9	0.2
9 DEGREE APPROACH -- TARGET IAS 63 MPH													
H18	88.3	79.8	8.5	6.3	0.3	91.0	91.9	92.8	6.2	86.6	22.5	21.0	1.0
H19	86.9	78.6	8.2	6.3	0.3	89.1	90.4	91.0	6.2	85.0	20.5	20.0	0.6
H20	88.2	80.4	7.8	6.6	0.4	90.6	92.3	93.4	6.3	87.1	15.0	14.5	1.1
H21	85.6	76.4	9.2	6.9	0.4	87.9	88.1	89.2	6.6	82.3	21.5	20.5	1.1
Avg.	87.2	78.8	8.4	6.5	0.4	89.7	90.7	91.6	6.3	85.3	19.9	19.0	0.9
Std Dv	1.2	1.8	0.6	0.3	0.0	1.4	1.9	1.9	0.2	2.2	3.4	3.0	0.3
90% CI	1.5	2.1	0.7	0.4	0.1	1.7	2.2	2.2	0.2	2.6	3.9	3.6	0.3

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED
FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.3-5.1 (REV.1)

AEROSPATIALE AS-3500 HELICOPTER (ASTAR)

DOT/TSC
6/ 9/84

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 5 CENTERLINE - 188 M. EAST JUNE 8,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
TAKEOFF -- TARGET IAS 63 MPH (ICAO)													
E11	86.9	79.1	7.8	6.7	0.4	90.6	90.6	92.6	7.1	83.8	14.5	13.5	1.9
E12	84.7	76.3	8.4	7.0	0.4	89.3	89.6	91.8	6.6	83.6	15.5	14.0	2.5
E13	85.3	76.9	8.4	6.9	0.4	89.4	89.5	92.1	6.5	83.8	16.5	13.5	2.7
E15	84.5	76.7	7.8	6.6	0.4	88.7	89.4	91.7	6 2	83.1	15.0	13.5	2.3
E16	84.8	76.5	8.3	6.6	0.4	-	88.8	90.9	-	82.7	18.5	-	2.1
E17	84.4	75.0	9.3	7.2	0.4	88.4	87.7	89.8	7.1	82.1	19.5	16.5	2.2
Avg.	85.1	76.8	8.3	6.8	0.4	89.3	89.3	91.5	6.7	83.2	16.6	14.2	2.3
Std Dv	0.9	1.3	0.6	0.3	0.0	0.8	1.0	1.0	0.4	0.7	2.0	1.3	0.3
90% CI	0.8	1.1	0.5	0.2	0.0	0.8	0.8	0.8	0.4	0.6	1.7	1.2	0.2
6 DEGREE APPROACH -- TARGET IAS 63 MPH (ICAO)													
F1	92.1	84.4	7.7	7.2	0.5	95.1	96.7	97.5	7.3	92.6	11.5	11.0	0.8
F2	92.1	83.5	8.7	7.7	0.5	94.8	96.1	96.9	7.2	92.0	13.5	12.5	0.8
F3	90.9	83.5	7.4	6.7	0.4	93.7	95.8	96.6	6.7	91.5	13.0	11.5	0.7
F4	92.6	84.7	7.9	7.6	0.6	95.2	96.3	97.3	7.5	92.0	11.0	11.0	1.0
F5	92.1	84.0	8.1	7.5	0.5	94.7	96.4	97.2	7.1	91.7	12.0	11.5	0.7
F6	91.8	84.6	7.2	6.9	0.5	94.7	96.9	97.9	6.8	92.5	11.0	10.0	1.0
F8	92.9	84.7	8.2	7.0	0.4	95.2	96.9	97.7	6.6	92.5	15.0	13.5	0.9
F9	91.2	83.9	7.3	6.6	0.4	93.8	96.2	96.9	6.5	91.5	13.0	12.0	0.7
Avg.	92.0	84.2	7.8	7.1	0.5	94.6	96.4	97.2	7.0	92.0	12.5	11.6	0.8
Std Dv	0.7	0.5	0.5	0.4	0.1	0.6	0.4	0.5	0.4	0.4	1.4	1.1	0.1
90% CI	0.4	0.4	0.3	0.3	0.0	0.4	0.3	0.3	0.2	0.3	0.9	0.7	0.1

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED
FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.3-5.2 (REV.1)

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

DOT/TSC
6/ 9/84

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 5 CENTERLINE - 188 M. EAST JUNE 8,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
500 FT. FLYOVER -- TARGET IAS 143 MPH													
N41	83.9	76.2	7.8	7.6	0.6	86.8	88.2	89.7	7.0	85.7	10.5	10.5	1.4
N42	84.3	76.4	7.9	6.9	0.4	87.2	87.8	89.0	7.1	84.9	14.0	14.0	1.2
N43	84.0	76.5	7.5	7.0	0.5	87.2	88.3	89.6	6.8	86.7	12.0	13.0	1.5
N44	83.7	76.1	7.6	6.5	0.4	86.6	87.5	88.6	6.9	84.5	14.5	14.5	1.1
Avg.	84.0	76.3	7.7	7.0	0.5	87.0	88.0	89.2	7.0	85.4	12.7	13.0	1.3
Std Dv	0.2	0.2	0.2	0.4	0.1	0.3	0.4	0.5	0.1	1.0	1.8	1.8	0.2
90% CI	0.3	0.2	0.2	0.5	0.1	0.3	0.5	0.6	0.2	1.2	2.2	2.1	0.2
500 FT. FLYOVER -- TARGET IAS 130.5 MPH													
A22	83.0	75.3	7.7	7.3	0.5	86.1	86.9	88.5	7.3	84.1	11.5	11.0	1.7
A23	83.1	75.2	7.9	7.5	0.5	86.0	86.6	87.9	7.6	82.6	11.5	11.5	1.4
A24	83.2	75.5	7.7	6.9	0.4	-	87.5	88.5	-	84.2	13.5	-	1.0
A25	82.9	75.3	7.6	6.7	0.4	85.9	87.1	88.1	7.0	83.0	13.5	13.0	1.0
A26	82.8	75.3	7.5	6.6	0.4	86.1	87.6	89.0	6.4	84.8	14.0	13.0	1.3
A27	82.3	74.7	7.6	6.3	0.4	85.4	86.4	87.3	6.7	82.8	16.0	16.5	0.9
Avg.	82.9	75.2	7.7	6.9	0.4	85.9	87.0	88.2	7.0	83.6	13.3	13.0	1.2
Std Dv	0.3	0.3	0.2	0.4	0.1	0.3	0.5	0.6	0.5	0.9	1.7	2.2	0.3
90% CI	0.3	0.2	0.1	0.4	0.1	0.3	0.4	0.5	0.5	0.7	1.4	2.1	0.3
500 FT. FLYOVER -- TARGET IAS 116 MPH													
B28	83.1	75.5	7.7	7.1	0.5	86.2	87.3	88.2	7.4	82.6	12.0	12.0	1.4
B29	82.1	73.8	8.3	7.3	0.5	85.2	85.6	87.2	7.1	80.6	13.5	13.5	1.8
B30	83.1	75.7	7.3	6.8	0.4	86.4	88.3	89.4	6.6	84.4	12.0	11.5	1.0
B31	82.4	74.4	8.0	6.9	0.4	85.6	86.6	87.4	7.2	82.2	14.5	14.0	0.8
Avg.	82.7	74.9	7.8	7.0	0.5	85.9	86.9	88.1	7.1	82.5	13.0	12.7	1.3
Std Dv	0.5	0.9	0.4	0.2	0.0	0.5	1.1	1.0	0.3	1.5	1.2	1.2	0.4
90% CI	0.6	1.0	0.5	0.3	0.0	0.6	1.3	1.2	0.4	1.8	1.4	1.4	0.5
500 FT. FLYOVER -- TARGET IAS 101.5 MPH													
C32	82.6	74.5	8.0	6.8	0.4	85.7	86.2	87.1	7.2	81.9	15.5	15.5	1.3
C33	82.5	77.0	5.4	5.4	0.3	85.5	88.4	89.6	5.6	84.3	10.0	11.0	1.2
C34	82.3	75.0	7.3	6.3	0.4	85.6	86.9	88.0	6.6	81.3	14.5	14.5	1.0
C35	82.9	74.0	8.9	6.6	0.3	87.1	86.6	88.9	6.1	82.9	23.0	21.0	2.4
C36	82.7	74.9	7.8	6.4	0.4	85.9	87.0	88.3	6.3	81.4	17.0	16.5	1.3
Avg.	82.6	75.1	7.5	6.3	0.4	86.0	87.0	88.4	6.4	82.4	16.0	15.7	1.4
Std Dv	0.2	1.2	1.3	0.5	0.0	0.6	0.8	0.9	0.6	1.3	4.7	3.6	0.5
90% CI	0.2	1.1	1.2	0.5	0.0	0.6	0.8	0.9	0.5	1.2	4.5	3.4	0.5
500 FT. FLYOVER -- TARGET IAS 86 MPH													
M45	82.4	74.4	8.0	6.2	0.3	85.6	86.5	87.5	6.6	81.4	20.0	16.5	1.2
M46	82.3	73.5	8.8	7.4	0.5	85.6	85.7	86.9	7.4	81.9	15.5	15.0	1.2
M47	81.5	72.7	8.8	7.1	0.4	84.6	84.8	86.2	6.8	80.3	17.0	17.0	1.4
M48	82.4	74.3	8.1	6.9	0.4	85.8	86.4	87.4	7.3	81.3	15.0	14.5	1.0
Avg.	82.1	73.7	8.4	6.9	0.4	85.4	85.8	87.0	7.0	81.2	16.9	15.7	1.2
Std Dv	0.4	0.8	0.4	0.5	0.1	0.5	0.8	0.6	0.4	0.7	2.2	1.2	0.2
90% CI	0.5	0.9	0.5	0.6	0.1	0.6	0.9	0.7	0.4	0.8	2.6	1.4	0.2

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

TABLE NO. A.3-5.3 (REV.1)

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

DOT/TSC
6/ 9/84

SUMMARY NOISE LEVEL DATA

AS MEASURED *

SITE: 5 CENTERLINE - 188 M. EAST JUNE 8,1983

EV	SEL	ALm	SEL-ALm	K(A)	Q	EPNL	PNLm	PNLTm	K(P)	OASPLm	DUR(A)	DUR(P)	TC
1000 FT. FLYOVER -- TARGET IAS 130.5 MPH													
D37	79.3	71.2	8.1	6.3	0.3	-	82.7	84.1	-	80.3	19.0	-	1.4
D38	79.9	69.7	10.2	7.4	0.4	-	81.1	82.4	-	82.5	24.5	-	1.3
D39	79.2	69.2	10.0	7.4	0.4	-	80.4	81.7	-	76.6	22.5	-	1.5
D40	79.7	69.4	10.3	7.6	0.5	-	80.7	82.0	-	78.7	23.0	-	1.4
Avg.	79.5	69.9	9.7	7.2	0.4	-	81.2	82.6	-	79.5	22.2	-	1.4
Std Dv	0.3	0.9	1.0	0.6	0.1	-	1.0	1.1	-	2.5	2.3	-	0.1
90% CI	0.4	1.1	1.2	0.7	0.1	-	1.2	1.2	-	3.0	2.7	-	0.1
TAKEOFF -- TARGET IAS 63 MPH (MULTI-SEG SEE TEXT)													
G49	87.6	80.5	7.1	6.9	0.5	90.9	92.1	94.3	6.3	84.6	11.0	11.0	2.3
G50	86.6	77.6	9.0	7.4	0.5	89.6	89.2	91.2	7.0	82.4	16.5	15.5	2.0
G51	87.0	78.9	8.1	6.9	0.4	89.9	90.4	92.8	6.4	82.8	15.0	12.5	2.4
G52	87.2	79.6	7.6	7.0	0.5	90.2	91.5	93.9	6.1	82.9	12.5	11.0	2.3
G53	86.1	78.7	7.4	6.6	0.4	89.2	90.5	92.6	6.3	82.5	13.5	11.0	2.2
G54	85.5	78.1	7.4	6.6	0.4	88.4	89.3	91.1	6.5	82.8	13.0	13.0	2.0
Avg.	86.7	78.9	7.8	6.9	0.4	89.7	90.5	92.6	6.5	83.0	13.6	12.3	2.2
Std Dv	0.8	1.0	0.7	0.3	0.0	0.8	1.2	1.3	0.3	0.8	1.9	1.8	0.2
90% CI	0.6	0.8	0.5	0.2	0.0	0.7	1.0	1.1	0.3	0.7	1.6	1.5	0.1
9 DEGREE APPROACH -- TARGET IAS 63 MPH													
H18	91.9	85.9	6.1	6.1	0.4	94.4	97.6	96.6	6.3	93.5	10.0	8.5	1.0
H19	88.4	82.3	6.1	7.0	0.5	91.4	94.6	95.1	7.0	89.2	7.5	8.0	0.6
H20	89.7	82.4	7.3	6.6	0.4	92.4	95.0	95.7	6.7	89.8	12.5	10.0	0.9
H21	87.7	80.5	7.2	6.9	0.5	-	92.7	93.4	-	87.4	11.0	-	0.7
Avg.	89.5	82.8	6.7	6.7	0.5	92.8	95.0	95.7	6.7	90.0	10.2	8.8	0.8
Std Dv	1.8	2.2	0.7	0.4	0.1	1.5	2.0	2.1	0.3	2.6	2.1	1.0	0.2
90% CI	2.2	2.6	0.8	0.5	0.1	2.6	2.4	2.5	0.6	3.0	2.5	1.8	0.2

* - NOISE INDEXES CALCULATED USING MEASURED DATA UNCORRECTED
FOR TEMPERATURE,HUMIDITY,OR AIRCRAFT DEVIATION FROM REF FLIGHT TRACK

APPENDIX B

Direct Read Acoustical Data and Duration Factors for Flight Operations

In addition to the magnetic recording systems, four direct-read, Type-1 noise measurement systems were deployed at selected sites during flight operations. The data acquisition is described in Section 5.6.2.

These direct read systems collected single event data consisting of maximum A-weighted sound level (AL), Sound Exposure Level (SEL), integration time (T), and equivalent sound level (LEQ). The SEL and dBA, as well as the integration time were put into a computer data file and analyzed to determine two figures of merit related to the event duration influence on the SEL energy dose metric. The data reduction is further described in Section 6.2.2; the analysis of these data is discussed in Section 9.3.

This appendix presents direct read data and contains the results of the helicopter noise duration effect analysis for flight operations. The direct read acoustical data for static operations is presented in Appendix D.

Each table within this appendix provides the following information:

Run No.	The test run number
SEL(dB)	Sound Exposure Level, expressed in decibels
AL(dB)	A-Weighted Sound Level, expressed in decibels
T(10-dB)	Integration time
K(A)	Propagation constant describing the change in dBA with distance
Q	Time history "shape factor"
Average	The average of the column
N	Sample size
Std Dev	Standard Deviation
90% C.I.	Ninety percent confidence interval
Mic Site	The centerline mircophone site at which the measurements were taken

TABLE B.1.1

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER/TARGET IAS=130.5 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
A22	83.2	75.7	NA	NA	NA
A23	83.3	75.2	NA	NA	NA
A24	83.6	76.1	NA	NA	NA
A25	83.1	75.2	NA	NA	NA
A26	83	75.5	NA	NA	NA
A27	82.5	74.4	NA	NA	NA
AVERAGE	83.10	75.40			
N	6	6			
STD.DEV.	0.37	0.58			
90% C.I.	0.30	0.47			

TABLE B.1.2

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER/TARGET IAS=130.5 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
A22	82.7	75.1	11.5	7.2	.5
A23	82.7	75.6	11	6.8	.5
A24	83.4	75.9	12.5	6.8	.4
A25	83.5	75.5	14	7	.5
A26	84	76.7	10	7.3	.5
A27	82.8	73.7	20	7	.4
AVERAGE	83.20	75.40	13.20	7.00	.5
N	6	6	6	6	6
STD.DEV.	0.53	1.00	3.61	.19	.05
90% C.I.	0.44	0.82	2.97	.15	.04

TABLE B.1.3

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER/TARGET IAS=130.5 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
A22	82.7	75.7	11	6.7	.5
A23	83.1	75.4	13	6.9	.5
A24	83.1	75.1	12	7.4	.5
A25	82.9	74.9	14	7	.5
A26	83.5	75.1	13	7.5	.5
A27	83	75.3	14	6.7	.4
AVERAGE	83.10	75.30	12.80	7.00	.5
N	6	6	6	6	6
STD.DEV.	0.27	0.28	1.17	.35	.05
90% C.I.	0.22	0.23	0.96	.29	.04

TABLE B.2.1

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER/TARGET IAS=116 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
B28	83.1	75.6	NA	NA	NA
B29	81.9	73.9	NA	NA	NA
B30	83.1	75.7	NA	NA	NA
B31	81.9	74.1	NA	NA	NA
AVERAGE	82.50	74.80			
N	4	4			
STD.DEV.	0.69	0.96			
90% C.I.	0.82	1.13			

TABLE B.2.2

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER/TARGET IAS=116 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
B28	82.2	75.5	12.5	6.1	.4
B29	82.2	74	15.5	6.9	.4
B30	83.1	75	12	7.5	.5
B31	82.1	73.9	12.5	7.5	.5
AVERAGE	82.40	74.60	13.10	7.00	.5
N	4	4	4	4	4
STD.DEV.	0.47	0.78	1.60	.66	.08
90% C.I.	0.55	0.92	1.88	.77	.09

TABLE B.2.3

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER/TARGET IAS=116 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
B28	81.8	73.3	13	7.6	.5
B29	82.6	74.6	13	7.2	.5
B30	83.6	75.9	16	6.4	.4
B31	82.5	74.3	13	7.4	.5
AVERAGE	82.60	74.50	13.80	7.10	.5
N	4	4	4	4	4
STD.DEV.	0.74	1.07	1.50	.53	.07
90% C.I.	0.87	1.26	1.77	.63	.09

TABLE B.3.1

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER/TARGET IAS=101.5 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
C32	82.4	74.5	NA	NA	NA
C33	82.8	77.4	NA	NA	NA
C34	82.1	74.6	NA	NA	NA
C35	82.5	74	NA	NA	NA
C36	82.4	74.3	NA	NA	NA
AVERAGE	82.40	75.00			
N	5	5			
STD.DEV.	0.25	1.38			
90% C.I.	0.24	1.32			

TABLE B.3.2

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER/TARGET IAS=101.5 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
C32	82.6	74	16	7.1	.5
C33	82.9	76.7	12	5.7	.3
C34	82.2	73.8	17	6.8	.4
C35	81.8	73.5	18	6.6	.4
C36	82.6	73.7	16	7.4	.5
AVERAGE	82.40	74.30	15.80	6.70	.4
N	5	5	5	5	5
STD.DEV.	0.43	1.33	2.28	.63	.06
90% C.I.	0.41	1.27	2.17	.6	.05

TABLE B.3.3

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER/TARGET IAS=101.5 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
C32	81.7	73.4	14	7.2	.5
C33	82.2	73.6	16	7.1	.5
C34	81.7	72.6	17	7.4	.5
C35	81.9	73.4	16	7.1	.4
C36	82.7	74.4	17	6.7	.4
AVERAGE	82.00	73.50	16.00	7.10	.5
N	5	5	5	5	5
STD.DEV.	0.42	0.64	1.22	.24	.03
90% C.I.	0.40	0.61	1.17	.23	.03

TABLE B.4.1

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 1000 FT.FLYOVER/TARGET IAS=130.5 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
D37	79	71.1	NA	NA	NA
D38	82.2	71.1	NA	NA	NA
D39	79.3	69.2	NA	NA	NA
D40	79	69.4	NA	NA	NA
AVERAGE	79.90	70.20			
N	4	4			
STD.DEV.	1.56	1.04			
90% C.I.	1.83	1.23			

TABLE B.4.2

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 1000 FT.FLYOVER/TARGET IAS=130.5 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
D37	79.6	70.7	18	7.1	.4
D38	79.9	69.6	23	7.6	.5
D39	79.7	69	22	8	.5
D40	79.6	69.3	25	7.4	.4
AVERAGE	79.70	69.70	22.00	7.50	.5
N	4	4	4	4	4
STD.DEV.	0.14	0.74	2.94	.37	.05
90% C.I.	0.17	0.87	3.46	.44	.06

TABLE B.4.3

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 1000 FT.FLYOVER/TARGET IAS=130.5 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
D37	80.4	71.9	16	7.1	.4
D38	79.5	69.5	21	7.6	.5
D39	79.8	70.5	20	7.1	.4
D40	79.3	68.9	25	7.4	.4
AVERAGE	79.80	70.20	20.50	7.30	.4
N	4	4	4	4	4
STD.DEV.	0.48	1.31	3.70	.24	.02
90% C.I.	0.56	1.54	4.35	.28	.03

TABLE B.5.1

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: ICAO TAKEOFF/TARGET IAS=63 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
E10	85.9	77.2	NA	NA	NA
E11	87	78.9	NA	NA	NA
E12	84.5	76.4	NA	NA	NA
E13	85.2	76.1	NA	NA	NA
E14	84.4	74.9	NA	NA	NA
E15	84.6	76.1	NA	NA	NA
E16	NA	NA	NA	NA	NA
E17	84.5	74.9	NA	NA	NA
AVERAGE	85.20	76.40			
N	7	7			
STD.DEV.	0.97	1.39			
90% C.I.	0.72	1.02			

TABLE B.5.2

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: ICAO TAKEOFF/TARGET IAS=63 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
E10	84.6	75.3	20	7.1	.4
E11	83.7	72.1	NA	NA	NA
E12	82.5	72.9	22	7.2	.4
E13	83.1	73.9	19	7.2	.4
E14	NA	NA	NA	NA	NA
E15	83	72.9	22.5	7.5	.5
E16	82.7	71.5	29	7.7	.5
E17	84.1	75.1	19	7	.4
AVERAGE	83.40	73.40	21.90	7.30	.4
N	7	7	6	6	6
STD.DEV.	0.77	1.45	3.77	.24	.02
90% C.I.	0.57	1.06	3.10	.19	.01

TABLE B.5.3

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: ICAO TAKEOFF/TARGET IAS=63 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
E10	83.9	73.2	30	7.2	.4
E11	82	69.9	34	7.9	.5
E12	81.9	71.7	22	7.6	.5
E13	81.6	71.6	24	7.2	.4
E14	81.1	69.9	26	7.9	.5
E15	81.6	70.5	24	8	.5
E16	82	71.3	30	7.2	.4
E17	82.6	71.4	25	8	.5
AVERAGE	82.10	71.20	26.90	7.70	.5
N	8	8	8	8	8
STD.DEV.	0.85	1.09	4.05	.36	.06
90% C.I.	0.57	0.73	2.71	.24	.04

TABLE B.6.1

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 6 DEGREE APPROACH/TARGET IAS=63 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
F1	92.7	85	NA	NA	NA
F2	92.5	83.9	NA	NA	NA
F3	91.2	84.1	NA	NA	NA
F4	93	85.2	NA	NA	NA
F5	92.5	84.9	NA	NA	NA
F6	92	85.4	NA	NA	NA
F7	92.1	84	NA	NA	NA
F8	93.4	85.3	NA	NA	NA
F9	92	84.3	NA	NA	NA
AVERAGE	92.40	84.70			
N	9	9			
STD.DEV.	0.64	0.60			
90% C.I.	0.40	0.37			

TABLE B.6.2

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 6 DEGREE APPROACH/TARGET IAS=63 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
F1	91.9	83.6	12.5	7.6	.5
F2	91.7	83.5	13	7.4	.5
F3	91.8	82.6	14	8	.6
F4	91.6	83.8	13	7	.5
F5	91.2	82.3	15	7.6	.5
F6	91.6	82.6	16	7.5	.5
F7	91.8	83.2	15	7.3	.5
F8	90.5	81.4	15.5	7.6	.5
F9	91.6	83.1	[illegible]	7.9	.6
AVERAGE	91.50	82.90	14.00	7.50	.5
N	9	9	9	9	9
STD.DEV.	0.43	0.76	1.44	.3	.04
90% C.I.	0.27	0.47	0.89	.19	.03

TABLE B.6.3

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 6 DEGREE APPROACH/TARGET IAS=63 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
F1	NA	NA	NA	NA	NA
F2	91.2	81.5	19	7.6	.5
F3	90.6	81.6	17	7.3	.5
F4	89.5	80	16	7.9	.6
F5	90.5	81	16	7.9	.6
F6	91.1	82.7	16	7	.4
F7	90.9	81.7	16	7.6	.5
F8	89.7	80	16	8.1	.6
F9	91	82	14	7.[illegible]	.6
AVERAGE	90.60	81.30	16.30	7.70	.5
N	8	8	8	8	8
STD.DEV.	0.64	0.94	1.39	.36	.05
90% C.I.	0.43	0.63	0.93	.24	.04

TABLE B.7.1

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: TAKEOFF/TARGET IAS=63 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
649	87.4	80	NA	NA	NA
650	86.4	77.4	NA	NA	NA
651	86.8	78.8	NA	NA	NA
652	87.1	79.5	NA	NA	NA
653	86.4	78.9	NA	NA	NA
654	85.7	78.2	NA	NA	NA
AVERAGE	86.60	78.80			
N	6	6			
STD.DEV.	0.60	0.92			
90% C.I.	0.50	0.76			

TABLE B.7.2

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: TAKEOFF/TARGET IAS=63 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
649	85.5	76.7	17	7.2	.4
650	85.4	75.9	19	7.4	.5
651	84	74.6	18	7.5	.5
652	85.5	76.4	15	7.7	.5
653	84.1	75.3	14	7.7	.5
654	84.5	76.2	14	7.2	.5
AVERAGE	84.80	75.90	16.20	7.50	.5
N	6	6	6	6	6
STD.DEV.	0.71	0.78	2.14	.23	.04
90% C.I.	0.59	0.64	1.76	.19	.03

TABLE B.7.3

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: TAKEOFF/TARGET IAS=63 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
649	84.9	74.9	20	7.7	.5
650	NA	NA	21	NA	NA
651	84	74.4	22	7.2	.4
652	84.3	74.6	23	7.1	.4
653	83.4	74.4	18	7.2	.4
654	83.4	74	18	7.5	.5
AVERAGE	84.00	74.50	20.30	7.30	.4
N	5	5	6	5	5
STD.DEV.	0.64	0.33	2.07	.25	.04
90% C.I.	0.61	0.31	1.70	.24	.04

TABLE B.8.1

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 9 DEGREE APPROACH/TARGETIAS=63 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
H18	92.2	85.9	NA	NA	NA
H19	88.2	82.2	NA	NA	NA
H20	89.3	82.7	NA	NA	NA
H21	87.7	80.6	NA	NA	NA
AVERAGE	89.40	82.90			
N	4	4			
STD.DEV.	2.01	2.22			
90% C.I.	2.37	2.61			

TABLE B.8.2

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 9 DEGREE APPROACH/TARGETIAS=63 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
H18	90.6	82.8	11	7.5	.5
H19	87	78.7	16	6.9	.4
H20	88.6	80.9	12	7.1	.5
H21	86.7	78.6	12	7.5	.5
AVERAGE	88.20	80.30	12.80	7.30	.5
N	4	4	4	4	4
STD.DEV.	1.79	2.00	2.22	.3	.06
90% C.I.	2.11	2.36	2.61	.35	.07

TABLE B.8.3

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 9 DEGREE APPROACH/TARGETIAS=63 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
H18	88.9	80	19	7	.4
H19	87.5	79.3	13	7.4	.5
H20	88.8	80.8	15	6.8	.4
H21	85.9	76.8	21	6.9	.4
AVERAGE	87.80	79.20	17.00	7.00	.4
N	4	4	4	4	4
STD.DEV.	1.40	1.73	3.65	.25	.05
90% C.I.	1.65	2.03	4.30	.29	.06

TABLE B.9.1

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER/TARGET IAS=86 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
M45	82.5	74.5	NA	NA	NA
M46	82.2	73.4	NA	NA	NA
M47	81.4	72.7	NA	NA	NA
M48	82.8	73.9	NA	NA	NA
AVERAGE	82.20	73.60			
N	4	4			
STD.DEV.	0.60	0.76			
90% C.I.	0.71	0.90			

TABLE B.9.2

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER/TARGET IAS=86 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
M45	83.6	74.8	17	7.2	.4
M46	82	73.8	15	7	.4
M47	81.5	72.7	15	7.5	.5
M48	82.2	73.1	17	7.4	.5
AVERAGE	82.30	73.60	16.00	7.30	.5
N	4	4	4	4	4
STD.DEV.	0.90	0.92	1.15	.23	.03
90% C.I.	1.06	1.08	1.36	.27	.04

TABLE B.9.3

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER/TARGET IAS=86 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
M45	83.8	74	17	8	.6
M46	81.9	71.9	20	7.7	.5
M47	81.6	73.1	14	7.4	.5
M48	82.1	73.1	16	7.5	.5
AVERAGE	82.40	73.00	16.80	7.60	.5
N	4	4	4	4	4
STD.DEV.	0.99	0.86	2.50	.25	.03
90% C.I.	1.16	1.01	2.94	.29	.03

TABLE B.10.1

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER/TARGET IAS=143 MPH

MIC SITE: 5

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
N41	83.2	76.7	NA	NA	NA
N42	84.1	76.4	NA	NA	NA
N43	84	76.6	NA	NA	NA
N44	83.7	75.9	NA	NA	NA
AVERAGE	83.80	76.40			
N	4	4			
STD.DEV.	0.40	0.36			
90% C.I.	0.48	0.42			

TABLE B.10.2

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER/TARGET IAS=143 MPH

MIC SITE: 1

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
N41	84.3	77	12	6.8	.4
N42	83.9	75.7	12	7.6	.6
N43	84.9	77.2	11	7.4	.5
N44	83.7	75.6	14	7.1	.5
AVERAGE	84.20	76.40	12.30	7.20	.5
N	4	4	4	4	4
STD.DEV.	0.53	0.84	1.26	.37	.05
90% C.I.	0.62	0.79	1.48	.43	.06

TABLE B.10.3

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER/TARGET IAS=143 MPH

MIC SITE: 4

RUN NO.	SEL(DB)	AL(DB)	T(10-DB)	K(A)	Q
N41	84.4	76.8	10	7.6	.6
N42	83.7	76	13	6.9	.5
N43	84.1	76.6	11	7.2	.5
N44	84.8	76.8	12	7.4	.5
AVERAGE	84.30	76.60	11.50	7.30	.5
N	4	4	4	4	4
STD.DEV.	0.47	0.38	1.29	.3	.05
90% C.I.	0.55	0.45	1.52	.35	.06

APPENDIX C

Magnetic Recording Acoustical Data for Static Operations

This appendix contains time averaged, A-weighted sound level data along with time averaged, one-third octave sound pressure level information for eight different directivity emission angles. These data were acquired June 6 using the TSC magnetic recording system discussed in Section 5.6.1.

Thirty-two seconds of corrected raw spectral data (64 contiguous 1/2 second data records) have been energy averaged to produce the data tabulated in this appendix. The spectral data presented are "As Measured" for the given emission angles established relative to each microphone location. Also included in the tables are the 360 degree (eight emission angle) average levels, calculated by both arithmetic and energy averaging. The data reduction is further described in Section 6.1. Figure 6.1 (previously shown) provides the reader with a quick reference to the emission angle convention.

The data cor ned in these tables have been used in analyses presented in Sections 9.2 and 9.7. The reader may cross reference the magnetic recording data of this appendix with direct read static data presented in Appendix D.

TABLE NO. C.3-1H.1

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

DOT/TSC
4/21/84

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

SITE: 1H (SOFT) - 150 M. NW JUNE 8,1983

HOVER-IN-GROUND-EFFECT

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	90	135	180	225	270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	50.1	52.4	48.9	52.8	51.7	49.8	49.4	50.7	50.9	6.2	50.7	1.4
15	59.2	62.1	59.8	62.9	62.1	60.1	58.9	60.3	60.9	21.5	60.7	1.5
16	70.0	72.6	70.8	72.2	72.6	71.0	69.6	71.4	71.4	36.8	71.3	1.1
17	59.7	62.5	57.8	62.2	60.5	62.2	59.3	59.2	60.7	30.5	60.4	1.7
18	69.6	71.5	64.0	74.4	75.9	71.6	66.6	67.8	71.7	45.5	70.2	4.0
19	62.4	64.0	62.2	65.0	65.4	66.8	62.2	61.5	64.1	41.6	63.7	1.9
20	58.8	59.2	59.2	62.3	63.9	67.6	61.5	58.4	62.6	43.5	61.4	3.2
21	68.0	67.8	65.8	66.6	72.1	68.3	72.0	72.2	69.8	53.7	69.1	2.6
22	61.5	61.6	60.7	63.9	66.5	68.1	64.1	63.5	64.4	51.0	63.7	2.6
23	65.3	64.2	64.3	65.0	68.0	69.2	67.8	65.9	66.6	55.7	66.2	1.9
24	59.3	64.4	62.5	65.2	65.9	69.0	61.8	62.8	64.8	56.2	63.9	2.9
25	56.6	62.5	60.9	63.7	63.6	65.0	58.1	59.4	62.0	55.4	61.2	3.0
26	55.2	57.6	54.8	58.6	62.7	60.3	55.2	56.4	58.5	53.7	57.6	2.8
27	52.4	52.8	50.8	53.8	60.2	58.4	52.3	52.3	55.4	52.2	54.1	3.3
28	49.1	51.2	49.1	51.0	55.5	55.3	50.5	51.7	52.3	50.4	51.7	2.5
29	48.6	51.5	48.3	49.3	53.5	54.3	51.7	52.8	51.8	51.0	51.2	2.3
30	48.2	50.4	47.9	48.4	51.9	52.9	51.8	52.6	50.9	50.9	50.5	2.1
31	47.7	51.5	48.3	48.3	51.2	53.9	51.4	54.4	51.5	52.1	50.8	2.6
32	45.7	49.6	47.0	46.4	48.8	51.4	51.1	53.0	49.8	50.8	49.1	2.6
33	44.0	48.7	45.4	45.0	47.6	49.9	48.2	52.4	48.5	49.7	47.6	2.8
34	42.4	46.8	44.1	43.7	46.2	48.2	48.2	51.7	47.4	48.7	46.4	3.0
35	41.6	46.4	43.0	42.8	45.3	48.1	48.0	50.9	46.8	48.0	45.8	3.2
36	39.7	43.5	41.1	40.2	42.3	45.0	46.0	49.1	44.5	45.5	43.4	3.2
37	37.8	40.8	39.0	37.2	39.2	42.7	44.0	46.4	42.0	42.5	40.9	3.2
38	36.3	39.2	37.0	35.0	37.2	40.8	42.8	44.6	40.3	40.2	39.1	3.4
39	33.4	36.3	35.0	32.0	33.8	38.5	40.3	41.8	37.6	36.5	36.4	3.5
40	29.2	31.9	29.5	28.[illegible]	30.0	33.8	35.5	36.7	32.9	30.4	31.9	3.1
AL	61.3	63.8	61.8	63.8	66.5	67.2	64.2	65.2	64.6	64.6	64.2	2.1
OASPL	75.7	77.5	74.8	78.5	80.1	78.8	76.7	77.2	77.7	-	77.4	1.7
PNL	75.2	77.2	75.0	77.1	79.6	80.9	78.5	79.5	78.2	-	77.9	2.1
PNLT	76.7	78.6	76.0	78.9	81.8	82.1	80.1	81.4	79.8	-	79.4	2.3

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE NO. C.3-1H.2

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/21/84

SITE: 1H (SOFT) - 150 M. NW JUNE 8,1983

FLIGHT IDLE

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	90	135	180	225	270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	49.5	52.4	47.6	52.6	47.6	47.4	50.8	49.7	50.2	5.5	49.7	2.1
15	60.3	61.0	59.6	60.3	58.9	60.0	60.8	59.6	60.1	20.7	60.1	0.7
16	67.8	66.4	66.9	66.1	66.2	67.4	67.5	66.9	66.9	32.3	66.9	0.6
17	60.2	59.8	62.9	58.7	59.2	60.8	60.8	59.8	60.5	30.3	60.3	1.3
18	70.6	69.4	69.5	73.1	71.9	70.5	67.8	69.3	70.5	44.3	70.3	1.7
19	58.8	57.6	57.7	59.5	58.3	60.4	60.9	58.1	59.1	36.6	58.9	1.2
20	55.0	55.6	57.6	56.6	57.1	59.3	60.1	56.3	57.5	38.4	57.2	1.8
21	63.6	61.5	65.1	63.4	68.9	65.2	66.8	69.8	66.4	50.3	65.5	2.8
22	55.3	54.6	59.6	57.7	59.9	60.4	60.6	59.2	58.9	45.5	58.4	2.3
23	60.9	57.6	63.5	62.4	63.8	65.1	65.5	64.7	63.5	52.6	62.9	2.6
24	58.4	58.0	63.2	61.6	61.7	63.2	63.6	61.4	61.8	53.2	61.4	2.1
25	53.6	56.4	60.6	59.6	57.6	59.5	60.8	59.4	58.9	52.3	58.4	2.4
26	47.2	52.0	54.8	53.8	51.1	53.5	55.0	53.2	53.1	48.3	52.6	2.5
27	39.3	44.8	47.4	46.9	41.8	44.6	46.5	45.4	45.2	42.0	44.6	2.8
28	35.9	39.3	41.5	42.1	37.1	40.6	42.1	40.2	40.3	38.4	39.8	2.3
29	34.3	40.6	40.2	40.3	36.7	40.1	40.8	39.0	39.4	38.6	39.0	2.3
30	35.3	40.6	41.1	41.0	37.4	41.2	41.2	39.5	40.1	40.1	39.7	2.2
31	36.0	40.5	40.7	40.2	37.2	40.8	41.3	38.7	39.8	40.4	39.4	1.9
32	34.8	38.6	38.8	38.8	35.8	38.4	39.1	37.9	38.0	39.0	37.8	1.6
33	34.2	37.6	37.9	37.8	35.2	37.0	38.1	37.2	37.1	38.3	36.9	1.4
34	31.7	36.2	36.2	35.8	34.0	34.8	36.7	35.0	35.3	36.6	35.0	1.6
35	30.7	35.4	34.8	34.5	32.8	33.8	35.7	33.7	34.2	35.4	33.9	1.6
36	28.3	33.4	33.1	32.6	31.9	31.8	33.7	31.9	32.3	33.3	32.1	1.7
37	27.0	33.3	31.6	30.3	30.6	29.8	31.7	30.0	30.9	31.4	30.5	1.8
38	26.3	30.9	29.9	28.8	29.3	28.8	29.8	28.7	29.2	29.1	29.1	1.3
39	24.5	28.3	27.2	26.4	26.8	26.8	27.0	26.1	26.7	25.6	26.6	1.1
40	23.2	25.5	24.7	24.8	24.8	24.4	25.5	24.1	24.7	22.2	24.6	0.8
AL	56.1	56.5	60.3	59.3	59.5	60.3	61.1	60.3	59.5	59.5	59.2	1.9
OASPL	74.1	73.0	74.5	75.5	75.6	75.0	74.7	75.1	74.7	-	74 7	0.8
PNL	68.9	69.5	72.9	71.9	72.5	73.1	73.7	73.3	72.1	-	72.0	1.8
PNLT	70.7	71.3	74.4	74.3	74.7	74.7	74.9	75.3	73.9	-	73.8	1.8

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE NO. C.3-1H.3

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/21/84

SITE: 1H (SOFT) - 150 M. NW JUNE 8,1983

GROUND IDLE****

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	90	135	180	225	270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	-	50.1	-	-	-	51.4	-	-	50.8	6.1	50.7	0.9
15	-	49.3	-	-	-	50.9	-	-	50.2	10.8	50.1	1.1
16	-	47.6	-	-	-	49.3	-	-	48.5	13.9	48.4	1.2
17	-	49.3	-	-	-	48.8	-	-	49.1	18.9	49.1	0.4
18	-	51.3	-	-	-	50.0	-	-	50.7	24.5	50.6	0.9
19	-	50.1	-	-	-	49.9	-	-	50.0	27.5	50.0	0.1
20	-	48.1	-	-	-	48.4	-	-	48.3	29.2	48.2	0.2
21	-	47.2	-	-	-	47.5	-	-	47.4	31.3	47.3	0.2
22	-	47.8	-	-	-	47.2	-	-	47.5	34.1	47.5	0.4
23	-	47.7	-	-	-	46.6	-	-	47.2	36.3	47.1	0.8
24	-	47.0	-	-	-	47.4	-	-	47.2	38.6	47.2	0.3
25	-	46.7	-	-	-	46.4	-	-	46.6	40.0	46.5	0.2
26	-	39.7	-	-	-	39.6	-	-	39.7	34.9	39.6	0.1
27	-	30.0	-	-	-	30.8	-	-	30.4	27.2	30.4	0.6
28	-	28.3	-	-	-	28.9	-	-	28.6	26.7	28.6	0.4
29	-	28.5	-	-	-	28.0	-	-	28.3	27.5	28.2	0.4
30	-	27.7	-	-	-	27.0	-	-	27.4	27.4	27.3	0.5
31	-	29.3	-	-	-	26.6	-	-	28.2	28.8	27.9	1.9
32	-	28.7	-	-	-	26.6	-	-	27.8	28.8	27.6	1.5
33	-	32.8	-	-	-	30.2	-	-	31.7	32.9	31.5	1.8
34	-	31.5	-	-	-	30.5	-	-	31.0	32.3	31.0	0.7
35	-	31.2	-	-	-	29.2	-	-	30.3	31.5	30.2	1.4
36	-	28.3	-	-	-	26.8	-	-	27.6	28.6	27.6	1.1
37	-	25.2	-	-	-	25.2	-	-	25.2	25.7	25.2	0.0
38	-	23.5	-	-	-	24.0	-	-	23.8	23.7	23.7	0.4
39	-	22.4	-	-	-	22.5	-	-	22.5	21.4	22.4	0.1
40	-	21.7	-	-	-	21.5	-	-	21.6	19.1	21.6	0.1
AL	-	46.3	-	-	-	45.8	-	-	46.1	46.1	46.1	0.4
OASPL	-	59.6	-	-	-	59.8	-	-	59.7	-	59.7	0.1
PNL	-	58.7	-	-	-	58.1	-	-	58.4	-	58.4	0.4
PNLT	-	59.6	-	-	-	58.4	-	-	58.9	-	59.0	0.8

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE NO. C.3-2H.1

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

DOT/TSC
4/21/84

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

SITE: 2 (SOFT) - 150 M. WEST JUNE 8,1983

HOVER-IN-GROUND-EFFECT

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	90	135	180	225	270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	56.4	58.5	56.1	55.0	55.3	54.6	54.0	55.5	55.9	11.2	55.7	1.4
15	62.3	65.0	63.5	64.9	64.6	63.3	62.1	63.7	63.8	24.4	63.7	1.1
16	73.3	75.3	74.3	74.1	75.4	74.3	73.1	75.0	74.4	39.8	74.3	0.9
17	63.6	65.4	63.6	64.1	64.1	65.4	63.5	63.4	64.2	34.0	64.1	0.8
18	72.6	73.2	68.8	77.7	78.1	73.8	69.4	69.3	74.2	48.0	72.9	3.6
19	64.3	65.8	64.8	66.9	67.6	66.8	63.9	64.3	65.8	43.3	65.5	1.4
20	60.0	60.4	63.4	63.2	66.5	64.6	62.4	61.2	63.2	44.1	62.7	2.2
21	69.5	66.0	69.7	69.9	74.1	66.7	73.1	71.2	70.8	54.7	70.0	2.8
22	61.6	60.4	65.0	65.7	67.0	65.9	65.5	64.2	64.9	51.5	64.4	2.3
23	65.8	63.9	67.2	66.8	69.8	67.4	72.7	67.7	68.4	57.5	67.7	2.6
24	60.0	64.7	67.0	67.0	70.0	67.1	65.1	65.5	66.5	57.9	65.8	2.9
25	60.8	64.7	66.6	67.7	69.5	66.8	64.6	64.8	66.3	59.7	65.7	2.6
26	62.2	64.1	64.7	68.1	69.0	67.2	63.4	64.4	66.0	61.2	65.4	2.4
27	61.6	61.9	61.8	67.7	68.7	65.7	61.7	63.1	65.0	61.8	64.0	2.9
28	58.3	60.4	58.8	64.9	67.1	62.7	60.4	61.0	62.7	60.8	61.7	3.0
29	53.3	55.7	53.4	58.9	61.8	54.9	54.8	55.2	57.0	56.2	56.0	2.9
30	51.7	49.9	49.7	55.2	57.4	51.9	50.6	51.0	53.1	53.1	52.2	2.7
31	55.3	50.7	48.9	56.7	57.9	54.1	50.4	50.9	54.2	54.8	53.1	3.3
32	55.3	50.4	47.6	56.7	56.2	54.2	50.7	50.5	53.7	54.7	52.7	3.3
33	53.3	49.6	45.5	55.6	53.9	52.0	47.8	49.0	51.9	53.1	50.8	3.4
34	52.2	48.6	44.7	54.5	51.6	50.9	47.7	48.0	50.7	52.0	49.8	3.1
35	51.2	46.9	43.1	52.6	50.2	50.2	47.2	47.0	49.4	50.6	48.5	3.1
36	47.9	43.8	40.9	49.1	46.5	47.1	44.8	45.3	46.3	47.3	45.7	2.6
37	44.8	39.7	38.1	45.7	42.2	44.5	42.0	42.5	43.1	43.6	42.4	2.6
38	42.9	37.8	35.3	43.2	38.8	42.9	40.3	40.6	40.9	40.8	40.2	2.8
39	39.3	34.8	32.8	39.5	34.8	40.1	37.7	37.8	37.7	36.6	37.1	2.7
40	33.3	28.4	26.4	33.2	28.3	34.7	32.4	32.3	31.9	29.4	31.1	3.0
AL	66.7	66.8	67.3	71.2	72.7	69.6	68.1	67.7	69.3	69.3	68.8	2.2
OASPL	78.4	79.4	78.9	81.6	83.0	80.0	79.6	79.3	80.3	-	80.0	1.5
PNL	79.4	79.2	79.3	83.6	84.4	82.2	81.9	79.9	81.6	-	81.2	2.1
PNLT	80.9	80.4	80.2	85.7	86.5	83.4	83.4	81.4	83.2	-	82.7	2.4

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE NO. C.3-2H.2

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/21/84

SITE: 2 (SOFT) - 150 M. WEST JUNE 8,1983

FLIGHT IDLE

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	90	135	180	225	270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	56.3	53.1	53.6	54.2	50.9	56.3	58.5	51.5	55.0	10.3	54.3	2.6
15	63.7	62.9	61.6	62.7	62.4	63.6	63.6	62.4	62.9	23.5	62.9	0.7
16	70.3	69.5	68.9	69.3	69.6	70.7	70.7	70.0	69.9	35.3	69.9	0.7
17	63.6	62.0	64.5	62.2	63.8	64.7	63.7	62.2	63.5	33.3	63.3	1.1
18	73.6	70.2	67.8	72.9	73.6	72.3	69.9	70.9	71.8	45.6	/1.4	2.1
19	61.1	59.3	57.7	60.7	62.1	63.2	61.9	60.4	61.1	38.6	60.8	1.7
20	56.8	57.4	58.1	57.5	58.5	61.1	59.5	57.4	58.5	39.4	58.3	1.4
21	65.9	64.8	66.7	65.6	69.9	65.9	69.6	71.8	68.2	52.1	67.5	2.5
22	56.6	58.1	60.8	60.3	59.8	61.0	60.5	60.8	60.0	46.6	59.7	1.6
23	63.4	62.0	65.1	65.2	64.7	67.5	66.7	65.9	65.4	54.5	65.1	1.8
24	59.1	63.4	64.1	65.7	63.7	64.1	63.3	62.7	63.6	55.0	63.3	1.9
25	56.2	63.5	62.1	64.7	61.4	62.6	62.0	61.2	62.2	55.6	61.7	2.5
26	54.4	61.8	59.6	61.4	58.2	61.8	59.7	59.0	60.0	55.2	59.5	2.5
27	51.4	57.9	55.8	56.8	54.6	59.6	56.3	56.2	56.6	53.4	56.1	2.4
28	46.6	53.5	49.6	52.5	48.7	55.9	52.5	51.1	52.1	50.2	51.3	2.9
29	39.3	46.4	41.3	45.5	41.8	49.4	46.0	43.7	45.2	44.4	44.2	3.3
30	38.6	42.1	38.8	42.4	41.3	44.8	42.8	41.6	42.0	42.0	41.5	2.1
31	38.8	42.2	39.8	41.7	42.6	43.3	42.1	42.4	41.8	42.4	41.6	1.5
32	38.6	41.3	39.9	42.5	43.2	42.2	41.5	42.5	41.7	42.7	41.5	1.5
33	37.9	40.4	38.5	40.9	42.6	41.7	40.2	42.8	40.9	42.1	40.6	1.8
34	36.7	38.8	37.6	39.1	41.8	40.7	39.0	42.1	39.8	41.1	39.5	1.9
35	34.0	36.9	35.8	37.3	39.8	38.5	37.6	40.5	38.0	39.2	37.5	2.1
36	32.0	34.3	34.0	35.0	38.4	36.0	35.5	38.6	36.0	37.0	35.5	2.2
37	30.8	31.9	32.5	32.6	37.1	33.5	33.1	35.4	33.8	34.3	33.4	2.0
38	29.3	29.4	30.9	30.5	34.7	31.9	31.2	33.3	31.8	31.7	31.4	1.9
39	25.8	25.9	27.9	27.0	31.2	28.9	27.5	29.9	28.4	27.3	28.0	1.9
40	21.6	21.7	23.4	23.0	26.7	23.9	24.0	25.6	24.1	21.6	23.7	1.8
AL	59.1	63.3	62.5	64.1	62.5	64.5	63.2	63.1	63.0	63.0	62.8	1.6
OASPL	76.9	75.7	75.4	77.0	77.6	77.5	77.0	77.2	76.8	-	76.8	0.8
PNL	72.3	74.9	74.4	76.0	75.8	76.9	75.8	76.6	75.3	-	75.3	1.5
PNLT	74.2	76.5	75.5	77.9	77.6	78.3	77.4	78.7	76.9	-	77.0	1.5

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE NO. C.3-2H.3

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/21/84

SITE: 2 (SOFT) - 150 M. WEST JUNE 8,1983

GROUND IDLE*****

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	90	135	180	225	270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	56.6	-	-	-	51.9	-	-	-	54.9	10.2	54.2	3.3
15	54.2	-	-	-	51.8	-	-	-	53.2	13.8	53.0	1.7
16	51.4	-	-	-	49.7	-	-	-	50.6	16.0	50.5	1.2
17	51.5	-	-	-	51.0	-	-	-	51.3	21.1	51.2	0.4
18	51.8	-	-	-	50.5	-	-	-	51.2	25.0	51..	0.9
19	50.6	-	-	-	50.7	-	-	-	50.7	28.2	50.6	0.1
20	48.5	-	-	-	48.7	-	-	-	48.6	29.5	48.6	0.1
21	46.1	-	-	-	46.7	-	-	-	46.4	30.3	46.4	0.4
22	45.4	-	-	-	45.7	-	-	-	45.6	32.2	45.5	0.2
23	44.6	-	-	-	45.8	-	-	-	45.2	34.3	45.2	0.8
24	43.5	-	-	-	46.4	-	-	-	45.2	36.6	44.9	2.1
25	43.9	-	-	-	45.0	-	-	-	44.5	37.9	44.4	0.8
26	41.8	-	-	-	41.2	-	-	-	41.5	36.7	41.5	0.4
27	34.9	-	-	-	35.8	-	-	-	35.4	32.2	35.3	0.6
28	31.9	-	-	-	31.8	-	-	-	31.9	30.0	31.8	0.1
29	30.0	-	-	-	29.6	-	-	-	29.8	29.0	29.8	0.3
30	28.7	-	-	-	28.3	-	-	-	28.5	28.5	28.5	0.3
31	27.8	-	-	-	29.8	-	-	-	28.9	29.5	28.8	1.4
32	28.3	-	-	-	31.3	-	-	-	30.1	31.1	29.8	2.1
33	29.1	-	-	-	34.1	-	-	-	32.3	33.5	31.6	3.5
34	30.5	-	-	-	34.5	-	-	-	32.9	34.2	32.5	2.8
35	28.8	-	-	-	33.4	-	-	-	31.7	32.9	31.1	3.3
36	25.9	-	-	-	32.2	-	-	-	30.1	31.1	29.0	4.5
37	24.2	-	-	-	29.4	-	-	-	27.5	28.0	26.8	3.7
38	22.1	-	-	-	26.1	-	-	-	24.5	24.4	24.1	2.8
39	20.8	-	-	-	23.2	-	-	-	22.2	21.1	22.0	1.7
40	20.1	-	-	-	21.2	-	-	-	20.7	18.2	20.6	0.8
AL	44.9	-	-	-	46.6	-	-	-	45.8	45.8	45.7	1.2
OASPL	61.8	-	-	-	60.3	-	-	-	61.1	-	61.1	1.1
PNL	57.0	-	-	-	59.5	-	-	-	58.4	-	58.2	1.8
PNLT	57.3	-	-	-	59.7	-	-	-	58.6	-	58.5	1.7

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

*****- TABULATED LEVELS ARE CONTAMINATED BY LOCAL AMBIENT

TABLE NO. C.3-4H.1

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/21/84

SITE: 4H (SOFT) - 300 M. WEST JUNE 8,1983

HOVER-IN-GROUND-EFFECT

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES)								AVERAGE LEVEL OVER 360 DEGREES			
	0	45	90	135	180	225	270	315	ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	51.0	52.0	49.8	51.7	49.6	48.9	50.4	50.3	50.6	5.9	50.5	1.1
15	54.2	57.2	56.6	58.1	56.7	55.8	54.7	55.0	56.2	16.8	56.0	1.3
16	65.2	67.1	66.4	66.6	67.3	66.2	65.1	66.0	66.3	31.7	66.2	0.8
17	55.5	55.9	56.3	58.8	56.0	57.4	54.6	54.1	56.3	26.1	56.1	1.5
18	64.5	63.4	61.4	70.1	70.1	64.7	60.6	59.7	66.0	39.8	64.3	4.0
19	55.8	56.3	58.1	60.7	59.3	58.6	55.8	55.6	57.9	35.4	57.5	1.9
20	51.1	51.5	56.9	58.1	62.1	56.7	54.0	52.1	56.9	37.8	55.3	3.8
21	59.0	56.6	61.5	61.8	64.2	57.1	64.1	60.7	61.4	45.3	60.6	2.9
22	51.4	50.1	56.5	56.7	57.1	54.0	55.9	54.7	55.1	41.7	54.5	2.6
23	55.3	52.7	56.5	56.8	59.9	54.6	61.3	58.0	57.7	46.8	56.9	2.8
24	49.4	51.2	55.3	56.6	58.9	53.8	54.6	55.0	55.2	46.6	54.3	3.0
25	48.8	49.5	53.7	55.6	57.5	51.7	52.2	52.7	53.6	47.0	52.7	2.9
26	46.3	44.9	48.9	53.7	54.8	48.6	47.7	48.5	50.5	45.7	49.2	3.4
27	41.7	40.6	42.9	50.0	51.2	43.0	41.9	42.3	46.2	43.0	44.2	4.0
28	37.2	38.7	39.9	46.1	47.5	38.4	37.2	40.1	42.5	40.6	40.6	4.0
29	36.0	39.9	38.7	44.3	45.1	36.9	37.4	40.0	41.0	40.2	39.8	3.3
30	37.0	40.1	39.4	44.2	44.3	36.6	38.2	39.9	40.9	40.9	40.0	2.9
31	38.2	39.8	39.6	44.5	44.1	37.0	38.3	39.7	41.0	41.6	40.1	2.7
32	37.5	39.3	39.0	43.3	41.9	36.8	38.3	39.0	39.9	40.9	39.4	2.2
33	35.7	36.7	37.1	41.0	39.7	33.7	35.0	37.1	37.6	38.8	37.0	2.4
34	34.2	35.4	35.9	40.2	37.9	32.3	34.5	35.4	36.4	37.7	35.7	2.4
35	32.6	34.2	34.1	38.5	35.7	31.6	33.3	33.4	34.7	35.9	34.2	2.1
36	-	30.8	30.0	33.6	-	-	29.4	-	31.3	32.3	30.9	1.9
37	-	-	-	-	-	-	-	-	-	-	-	-
38	-	-	-	-	-	-	-	-	-	-	-	-
39	-	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-	-
AL	51.9	52.0	54.8	57.7	58.9	53.0	55.4	54.5	55.5	55.5	54.8	2.5
OASPL	69.5	70.0	70.4	73.4	74.0	70.4	70.2	69.5	71.3	-	70.9	1.8
PNL	64.8	64.3	67.2	70.1	71.1	65.4	68.5	67.0	68.2	-	67.3	2.5
PNLT	66.3	65.5	68.0	71.9	73.2	66.5	70.0	68.2	69.7	-	68.7	2.8

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE NO. C.3-4H.2

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

DOT/TSC
4/21/84

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

SITE: 4H (SOFT) - 300 M. WEST JUNE 8,1983

FLIGHT IDLE

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	90	135	180	225	270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	48.5	48.1	49.6	54.0	51.6	52.7	47.2	53.5	51.3	6.6	50.6	2.6
15	55.8	53.8	54.1	55.2	55.1	56.1	54.4	55.4	55.1	15.7	55.0	0.8
16	62.1	60.5	61.1	60.5	61.5	62.5	62.1	61.2	61.5	26.9	61.4	0.8
17	56.3	51.3	55.1	52.8	54.7	57.1	55.1	53.4	54.8	24.6	54.5	1.9
18	65.7	60.7	59.2	62.5	64.5	63.3	61.3	61.4	62.8	36.6	62.3	2.1
19	53.3	49.7	49.3	50.9	52.8	57.6	53.3	51.2	53.1	30.6	52.3	2.7
20	51.1	49.8	49.2	48.8	50.1	55.4	51.5	48.4	51.2	32.1	50.5	2.2
21	58.7	58.3	56.9	55.7	60.5	56.6	60.6	61.5	59.0	42.9	58.6	2.1
22	48.4	49.7	51.3	49.7	49.6	52.0	51.0	50.6	50.4	37.0	50.3	1.2
23	53.9	51.2	54.4	52.8	52.8	55.4	55.1	55.5	54.1	43.2	53.9	1.5
24	48.0	51.8	51.1	51.8	50.8	51.0	50.2	51.0	50.8	42.2	50.7	1.2
25	43.8	49.7	47.0	48.9	46.9	47.4	47.0	47.8	47.6	41.0	47.3	1.8
26	39.0	46.4	41.3	42.9	40.6	43.6	41.7	43.2	42.9	38.1	42.3	2.2
27	34.0	41.6	35.6	35.7	35.2	40.1	35.8	37.2	37.7	34.5	36.9	2.6
28	31.1	36.6	32.3	34.3	33.0	37.8	32.9	31.8	34.3	32.4	33.7	2.4
29	31.2	36.4	33.1	35.5	33.8	37.8	34.7	32.3	34.8	34.0	34.3	2.2
30	32.2	36.4	34.5	36.3	34.9	38.2	36.4	33.1	35.6	35.6	35.2	2.0
31	32.3	36.3	34.8	36.9	34.8	37.7	36.7	33.4	35.7	36.3	35.4	1.9
32	31.1	35.3	34.4	36.2	34.7	36.9	35.6	33.4	35.0	36.0	34.7	1.8
33	30.0	33.6	33.0	34.1	33.4	35.4	33.7	31.9	33.4	34.6	33.1	1.6
34	29.6	31.8	31.8	32.3	32.2	33.3	32.5	29.9	31.8	33.1	31.7	1.3
35	-	30.0	-	29.9	30.8	-	30.4	-	30.3	31.5	30.3	0.4
36	-	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-	-
38	-	-	-	-	-	-	-	-	-	-	-	-
39	-	-	-	-	-	-	-	-	-	-	-	-
40	.	-	-	-	-	-	-	-	-	-	-	-
AL	49.2	51.1	50.0	50.4	50.5	51.5	51.0	51.1	50.7	50.7	50.6	0.7
OASPL	68.9	66.2	66.1	66.8	68.4	68.5	67.6	67.6	67.6	-	67.5	1.1
PNL	61.9	63.1	62.5	62.7	63.8	64.7	64.1	63.9	63.5	-	63.3	0.9
PNLT	63.7	64.8	63.6	64.5	65.6	65.7	65.7	65.9	65.0	-	64.9	0.9

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE NO. C.3-4H.3

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
4/21/84

SITE: 4H (SOFT) - 300 M. WEST JUNE 8,1983

GROUND IDLE*****

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	90	135	180	225	270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	48.2	-	-	-	52.7	-	-	-	51.0	6.3	50.4	3.2
15	47.4	-	-	-	51.4	-	-	-	49.8	10.4	49.4	2.8
16	46.7	-	-	-	49.6	-	-	-	48.4	13.8	48.1	2.1
17	47.3	-	-	-	48.8	-	-	-	48.1	17.9	48.1	1.1
18	50.2	-	-	-	49.3	-	-	-	49.8	23.6	49.7	0.6
19	48.4	-	-	-	49.4	-	-	-	48.9	26.4	48.9	0.7
20	46.2	-	-	-	45.6	-	-	-	45.9	26.8	45.9	0.4
21	43.3	-	-	-	42.6	-	-	-	43.0	26.9	42.9	0.5
22	40.8	-	-	-	39.8	-	-	-	40.3	26.9	40.3	0.7
23	38.2	-	-	-	37.7	-	-	-	38.0	27.1	37.9	0.4
24	33.3	-	-	-	34.2	-	-	-	33.8	25.2	33.7	0.6
25	30.4	-	-	-	30.5	-	-	-	30.5	23.9	30.4	0.1
26	26.0	-	-	-	25.6	-	-	-	25.8	21.0	25.8	0.3
27	23.4	-	-	-	24.7	-	-	-	24.1	20.9	24.0	0.9
28	24.6	-	-	-	25.4	-	-	-	25.0	23.1	25.0	0.6
29	24.8	-	-	-	25.6	-	-	-	25.2	24.4	25.2	0.6
30	24.7	-	-	-	24.3	-	-	-	24.5	24.5	24.5	0.3
31	23.2	-	-	-	23.9	-	-	-	23.6	24.2	23.5	0.5
32	21.5	-	-	-	22.6	-	-	-	22.1	23.1	22.1	0.8
33	21.2	-	-	-	22.3	-	-	-	21.8	23.0	21.7	0.8
34	22.5	-	-	-	22.8	-	-	-	22.7	24.0	22.6	0.2
35	26.8	-	-	-	23.6	-	-	-	25.5	26.7	25.2	2.3
36	23.3	-	-	-	24.7	-	-	-	24.1	25.1	24.0	1.0
37	-	-	-	-	22.1	-	-	-	22.1	22.6	22.1	-
38	-	-	-	-	19.7	-	-	-	19.7	19.6	19.7	-
39	-	-	-	-	19.1	-	-	-	19.1	18.0	19.1	-
40	-	-	-	-	19.1	-	-	-	19.1	16.6	19.1	-
AL	38.0	-	-	-	38.0	-	-	-	38.1	38.1	38.0	0.0
OASPL	56.8	-	-	-	58.7	-	-	-	57.9	-	57.7	1.3
PNL	50.4	-	-	-	49.7	-	-	-	50.0	-	50.0	0.5
PNLT	51.7	-	-	-	50.2	-	-	-	50.5	-	50.9	1.1

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

*****- TABULATED LEVELS ARE CONTAMINATED BY LOCAL AMBIENT

TABLE NO. C.3-5H.1 (REV.1)

AEROSPATIALE AS-350D HELICOPTER (ASTAR) DOT/TSC 6/11/84

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

SITE: 5H (HARD) - 150 M. NORTH JUNE 8,1983

HOVER-IN-GROUND-EFFECT

	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES)								AVERAGE LEVEL OVER 360 DEGREES			
BAND NO.	0	45	90	135	180	225	270	315	ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	-	-	-	-	61.6	61.1	-	-	61.4	16.7	61.4	0.4
15	-	-	-	-	63.5	63.4	-	-	63.5	24.1	63.4	0.1
16	-	-	-	-	72.1	72.5	-	-	72.3	37.7	72.3	0.3
17	-	-	-	-	63.7	65.8	-	-	64.9	34.7	64.7	1.5
18	-	-	-	-	77.8	75.2	-	-	76.7	50.5	76.5	1.9
19	-	-	-	-	68.4	70.0	-	-	69.3	45.8	69.2	1.1
20	-	-	-	-	65.5	69.2	-	-	67.7	48.6	67.3	2.6
21	-	-	-	-	76.0	73.1	-	-	74.8	58.7	74.6	2.1
22	-	-	-	-	70.9	73.3	-	-	72.3	58.9	72.1	1.7
23	-	-	-	-	74.6	75.2	-	-	74.9	64.0	74.9	0.4
24	-	-	-	-	75.3	77.3	-	-	76.4	67.8	76.3	1.4
25	-	-	-	-	75.8	78.1	-	-	77.1	70.5	76.9	1.6
26	-	-	-	-	76.5	78.7	-	-	77.7	72.9	77.6	1.6
27	-	-	-	-	76.9	78.4	-	-	77.7	74.5	77.6	1.1
28	-	-	-	-	75.5	76.9	-	-	76.3	74.4	76.2	1.0
29	-	-	-	-	71.9	73.2	-	-	72.6	71.8	72.5	0.9
30	-	-	-	-	70.0	71.2	-	-	70.6	70.6	70.6	0.8
31	-	-	-	-	69.5	70.9	-	-	70.3	70.9	70.2	1.0
32	-	-	-	-	67.8	68.6	-	-	68.2	69.2	68.2	0.6
33	-	-	-	-	65.2	65.8	-	-	65.5	66.7	65.5	0.4
34	-	-	-	-	63.1	63.9	-	-	63.5	64.8	63.5	0.6
35	-	-	-	-	61.2	62.5	-	-	61.9	63.1	61.8	0.9
36	-	-	-	-	56.7	57.7	-	-	57.2	58.2	57.2	0.7
37	-	-	-	-	52.3	53.7	-	-	53.1	53.6	53.0	1.0
38	-	-	-	-	50.8	52.5	-	-	51.7	51.6	51.6	1.2
39	-	-	-	-	46.5	48.7	-	-	47.7	46.6	47.6	1.6
40	-	-	-	-	39.7	42.0	-	-	41.0	38.5	40.8	1.6
AL	-	-	-	-	81.1	82.6	-	-	81.9	81.9	81.9	1.1
OASP	-	-	-	-	86.3	87.2	-	-	86.8	-	86.7	0.6
PNL	-	-	-	-	92.3	93.6	-	-	93.0	-	92.9	0.9
PNLT	-	-	-	-	94.2	94.8	-	-	94.6	-	94.5	0.4

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE NO. C.3-5H.2 (REV.1)

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

DOT/TSC
6/11/84

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

SITE: 5H (HARD) - 150 M. NORTH JUNE 8,1983

FLIGHT IDLE

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	90	135	180	225	270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	58.3	62.8	57.3	59.5	52.7	57.1	63.1	55.5	59.5	14.8	58.3	3.5
15	61.7	64.4	61.9	62.4	61.1	62.3	64.8	62.1	62.8	23.4	62.6	1.3
16	68.2	69.5	67.6	67.3	68.3	69.0	70.0	68.3	68.6	34.0	68.5	0.9
17	61.5	63.3	64.3	60.3	61.5	62.3	64.6	61.1	62.6	32.4	62.4	1.6
18	70.7	68.3	68.5	73.2	72.9	70.7	68.0	69.7	70.7	44.5	70.2	2.0
19	59.2	60.8	58.6	59.8	60.6	61.1	64.0	62.4	61.1	38.6	60.8	1.7
20	54.9	57.0	59.0	57.2	57.9	59.4	63.6	62.9	59.9	40.8	59.0	3.0
21	62.6	65.1	68.0	64.4	70.7	64.5	68.6	68.0	67.2	51.1	66.5	2.7
22	55.7	56.5	60.0	59.6	61.0	62.0	65.7	63.0	61.5	48.1	60.4	3.3
23	62.8	59.7	65.9	66.0	66.8	65.0	70.4	68.4	66.6	55.7	65.6	3.3
24	60.0	60.5	65.7	64.5	66.5	64.8	71.0	66.9	66.2	57.6	65.0	3.5
25	59.3	61.3	63.7	64.5	64.9	64.9	71.6	66.6	66.1	57.5	64.6	3.6
26	59.0	61.1	62.2	62.9	64.5	64.9	71.6	66.5	65.8	61.0	64.1	3.8
27	58.1	59.9	64.7	62.8	63.8	64.8	71.0	65.8	65.5	62.3	63.9	3.9
28	56.0	58.1	62.1	63.1	62.3	62.7	69.2	63.8	63.8	61.9	62.2	3.9
29	52.9	57.6	60.1	60.0	59.6	59.6	65.0	60.5	60.5	59.7	59.4	3.4
30	51.9	55.1	57.4	57.2	58.4	58.1	63.6	58.8	58.7	58.7	57.6	3.3
31	49.9	52.0	54.6	54.8	57.2	56.1	62.0	56.3	56.8	57.4	55.4	3.6
32	46.8	49.8	50.8	52.4	55.3	53.2	59.5	54.0	54.2	55.2	52.7	3.8
33	44.6	46.3	46.8	49.1	53.6	50.3	56.9	51.1	51.6	52.8	49.8	4.1
34	43.6	43.7	44.0	47.4	52.8	48.0	54.2	49.3	49.6	50.9	47.9	4.1
35	41.2	42.2	41.9	45.5	51.1	45.4	51.9	47.3	47.5	48.7	45.8	4.1
36	38.2	38.9	38.7	41.8	47.9	41.6	48.0	44.3	44.0	45.0	42.4	4.0
37	36.6	37.6	37.0	39.8	45.9	39.1	45.7	42.2	42.0	42.5	40.5	3.7
38	36.3	38.2	37.4	39.4	45.2	39.4	45.3	41.7	41.6	41.5	40.4	3.4
39	33.3	35.7	35.0	36.4	41.8	[illegible]	41.7	38.1	38.3	37.2	37.3	3.1
40	27.4	30.1	30.0	31.6	36.9	[illegible]	37.2	32.3	33.3	30.8	32.0	3.4
AL	63.0	65.1	68.2	68.2	69.4	68.9	75.0	70.1	69.8	69.8	68.5	3.5
OASPL	75.0	75.5	76.5	77.2	78.2	77.0	80.9	77.9	77.6	-	77.3	1.8
PNL	74.8	76.5	79.2	79.1	81.4	80.0	86.1	81.6	81.1	-	79.8	3.4
PNLT	76.5	77.9	80.4	81.3	83.4	81.5	86.7	82.9	82.6	-	81.3	3.2

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

TABLE NO. C.3-5H.3 (REV.1)

AEROSPATIALE AS-350D HELICOPTER (ASTAR)

1/3 OCTAVE NOISE DATA -- STATIC TESTS

AS MEASURED****

DOT/TSC
6/11/84

SITE: 5H (HARD) - 150 M. NORTH JUNE 8,1983

GROUND IDLE

BAND NO.	LEVELS @ ACOUSTIC EMMISION ANGLES OF (DEGREES) 0	45	90	135	180	225	270	315	AVERAGE LEVEL OVER 360 DEGREES ENERGY *	AVE **	ARITH ***	Std Dv
	SOUND PRESSURE LEVEL dB re 20 microPascal											
14	-	-	64.1	-	-	-	55.4	-	61.6	16.9	59.7	6.2
15	-	-	61.4	-	-	-	53.3	-	59.0	19.6	57.3	5.7
16	-	-	61.0	-	-	-	51.8	-	58.5	23.9	56.4	6.5
17	-	-	59.2	-	-	-	50.4	-	56.7	26.5	54.8	6.2
18	-	-	57.2	-	-	-	50.3	-	55.0	28.8	53.7	4.9
19	-	-	54.3	-	-	-	49.4	-	52.5	30.0	51.8	3.5
20	-	-	51.5	-	-	-	47.4	-	49.9	30.8	49.4	2.9
21	-	-	50.2	-	-	-	48.5	-	49.4	33.3	49.3	1.2
22	-	-	50.6	-	-	-	50.0	-	50.3	36.9	50.3	0.4
23	-	-	50.0	-	-	-	50.3	-	50.2	39.3	50.1	0.2
24	-	-	51.5	-	-	-	52.2	-	51.9	43.3	51.8	0.5
25	-	-	51.6	-	-	-	52.7	-	52.2	45.6	52.1	0.8
26	-	-	48.5	-	-	-	49.9	-	49.3	44.5	49.2	1.0
27	-	-	47.9	-	-	-	46.0	-	47.1	43.9	46.9	1.3
28	-	-	46.8	-	-	-	45.3	-	46.1	44.2	46.1	1.1
29	-	-	50.1	-	-	-	44.3	-	48.1	47.3	47.2	4.1
30	-	-	47.0	-	-	-	43.4	-	45.6	45.6	45.2	2.5
31	-	-	46.5	-	-	-	42.4	-	44.9	45.5	44.4	2.9
32	-	-	45.1	-	-	-	42.0	-	43.8	44.8	43.6	2.2
33	-	-	43.6	-	-	-	41.1	-	42.5	43.7	42.4	1.8
34	-	-	43.6	-	-	-	40.9	-	42.5	43.8	42.2	1.9
35	-	-	43.6	-	-	-	41.9	-	42.8	44.0	42.7	1.2
36	-	-	41.2	-	-	-	40.2	-	40.7	41.7	40.7	0.7
37	-	-	38.3	-	-	-	37.6	-	38.0	38.5	37.9	0.5
38	-	-	38.2	-	-	-	36.7	-	37.5	37.4	37.4	1.1
39	-	-	35.3	-	-	-	33.2	-	34.4	33.3	34.2	1.5
40	-	-	29.7	-	-	-	28.4	-	29.1	26.6	29.0	0.9
AL	-	-	57.1	-	-	-	55.0	-	56.2	56.2	56.1	1.5
OASPL	-	-	69.1	-	-	-	63.0	-	67.0	-	66.1	4.3
PNL	-	-	69.9	-	-	-	67.8	-	69.0	-	68.8	1.5
PNLT	-	-	70.9	-	-	-	68.1	-	69.5	-	69.5	2.0

BANDS 14 TO 40 - STANDARD 1/3 OCTAVE BANDS 25 TO 10KHz

* - UNWEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
** - A-WEIGHTED ENERGY AVERAGE OF MEASURED LEVELS OVER 360 DEGREES
*** - UNWEIGHTED ARITHMETIC AVERAGE OF MEASURED LEVELS OVER 360 DEGREES

**** - 32 SECOND AVERGING TIME

APPENDIX D

Direct Read Acoustical Data for Static Operations

This appendix contains time averaged, A-weighted sound level data (Leq values) obtained using direct read Precision Integrating Sound Level meters. Data are presented for microphone locations 5H, 2, and 4 (see Figure 3.3).

A description of the measurement systems is provided in Section 5.6.2, and a figure of the typical PISLM system is shown in Figure 5.4. Data are shown in Table D-1, depicting the equivalent sound levels for eight different source emission angles. In each case the angle is indexed to the specific measurement site. A figure showing the emission angle convention is included in the text (Figure 6.1). In each case, the Leq (or time averaged AL) represents an average over a sample period of approximately 60 seconds.

Quantities appearing in this appendix include:

HIGE	Hover-in-ground-effect, skid height 5 feet above ground level
HOGE	Hover-out-of-ground-effect, skid height 30 feet above ground level
Flight Idle	Skids on ground
Ground Idle	Skids on ground

TABLE D.1.1

STATIC OPERATIONS
DIRECT READ DATA
(ALL VALUES A-WEIGHTED LEQ, EXPRESSED IN DECIBLES)

ASTAR

6-8-83

SITE 4H (SOFT SITE)

HIGE		FLT.IDLE		GRN.IDLE	
I-0	54.30	J-0A	50.40	J-0B	40.30
I-315	56.80	J-315A	52.30	J-315B	NA
I-270	57.70	J-270A	53.30	J-270B	NA
I-225	55.20	J-225A	52.60	J-225B	NA
I-180	61.00	J-180A	52.20	J-180B	39.00
I-135	59.70	J-135A	51.90	J-135B	NA
I-90	56.30	J-90A	51.30	J-90B	NA
I-45	54.90	J-45A	51.80	J-45B	NA

SITE 2 (SOFT SITE)

HIGE		FLT.IDLE		GND.IDLE	
I-0	65.80	J-0A	59.40	J-0B	47.20
I-315	68.20	J-315A	62.00	J-315B	NA
I-270	68.10	J-270A	63.40	J-270B	NA
I-225	68.20	J-225A	63.70	J-225B	NA
I-180	72.30	J-180A	62.50	J-180B	46.10
I-135	71.40	J-135A	64.30	J-135B	NA
I-90	67.40	J-90A	62.00	J-90B	NA
I-45	65.40	J-45A	65.20	J-45B	NA

TABLE D.1.2

STATIC OPERATIONS
DIRECT READ DATA
(ALL VALUES A-WEIGHTED LEQ, EXPRESSED IN DECIBLES)

ASTAR

6-8-83

SITE 5H (HARD SITE)

HIGE		FLT.IDLE		GRN.IDLE	
I-0	NA	J-0A	68.80	J-0B	55.20
I-315	76.70	J-315A	66.70	J-315B	NA
I-270	73.70	J-270A	64.70	J-270B	NA
I-225	74.40	J-225A	69.00	J-225B	NA
I-180	78.00	J-180A	74.40	J-180B	56.00
I-135	83.50	J-135A	69.20	J-135B	NA
I-90	83.50	J-90A	NA	J-90B	NA
I-45	77.00	J-45A	NA	J-45B	NA

SITE 7H (HARD SITE)

HIGE		FLT.IDLE		GND.IDLE	
I-0	71.49	J-0A	59.67	J-0B	51.12
I-315	70.61	J-315A	59.54	J-315B	NA
I-270	66.03	J-270A	58.46	J-270B	NA
I-225	67.78	J-225A	62.97	J-225B	49.79
I-180	69.85	J-180A	67.50	J-180B	NA
I-135	74.99	J-135A	60.69	J-135B	NA
I-90	77.36	J-90A	62.48	J-90B	NA
I-45	70.14	J-45A	60.60	J-45B	NA

APPENDIX E

Cockpit Instrument Photo Data

During each event of the June 1983 Helicopter Noise Measurement program cockpit photos were taken. The slides were projected onto a screen (considerably enlarged) making it possible to read the instruments with reasonable accuracy. The photos were supposed to be taken when the aircraft was directly over the centerline-center microphone site. Although this was not achieved in each case the cockpit photos reflect the helicopter "stabilized" configuration during the test event. One important caution is necessary in interpreting the photographic information; the snapshot freezes instrument readings at one moment of time whereas most readings are constantly changing by a small amount as the pilot "hunts" for the reference condition. Thus fluctuations above or below ref^rence conditions are to be anticipated. The instrument readings are most useful in terms of verifying the region of operation for different parameters. The data acquisition is discussed in Section 5.3

Each table within this appendix provides the following information:

Event No.	This event number along with the test date provides a cross reference to other data.
Event Type	This specifies the event.
Time of Photo	The time of the range control synchronized clock consistent with acoustical and tracking time bases.
Heading	The compass magnetic heading which fluctuates around the target heading.
Altimeter	Specifies the barometric altimeter reading, one of the more stable indicators.
IAS	Indicated airspeed, a fairly stable indicator.
Rotor Speed	Main Rotor speed in RPM or percent, a very stable indicator.
Torque	The torque on the main rotor shaft, a fairly stable value.

TABLE E.1

COCKPIT PHOTO DATA

HELICOPTER ~~AStar~~ TEST DATE 6-8-83

EVENT NO.	EVENT TYPE	TIME OF PHOTO	HEADING (DEGREES)	ALTIMETER (AGL) FT. (METERS)	IAS (KTS)	ROTOR SPEED (RPM OR %)	TORQUE (%)
F6	APPROACH	9:38:46	125	760	65	380	26
F7	APPROACH	9:43:51	125	770	52	380	28
F8	APPROACH	9:46:34	125	750	62	380	30
F9	APPROACH	9:51:03	120	740	66	380	26
E10	TAKEOFF	9:55:53	310	500	58	360	96
E11	TAKEOFF	9:58:30	310	620	62	360	100
E12	TAKEOFF	10:20:37	-	480	60	360	98
E13	TAKEOFF	10:26:54	-	440	60	360	74
E14	TAKEOFF	10:29:48	300	460	56	360	98
E15	TAKEOFF	10:33:11	305	470	-	380	-
E16	TAKEOFF	10:35:28	-	540	65	380	98
E17	TAKEOFF	10:41:56	305	500	65	380	100
H18	APPROACH	10:46:13	-	680	-	380	22
H19	APPROACH	10:49:25	-	700	80	380	10
H20	APPROACH	10:53:38	-	720	74	380	20
H21	APPROACH	10:56:00	-	700	73	380	12
A22	500'LFO 0.9	11:02:18	120	780	130	385	84
A23	500'LFO 0.9	11:04:17	310	800	130	385	84
A24	500'LFO 0.9	11:06:27	120	780	130	385	82
A25	500'LFO 0.9	11:09:22	310	780	130	385	80
A26	500'LFO 0.9	11:11:22	120	770	130	385	78
A27	500'LFO 0.9	11:12:14	310	800	130	385	80
B28	500'LFO 0.8	11:21:49	125	800	118	385	64
B29	500'LFO 0.8	11:25:37	310	800	118	385	70
B30	500'LFO 0.8	11:27:35	120	780	-	385	62
B31	500'LFO 0.8	11:29:40	310	800	-	385	72

TABLE E.2

COCKPIT PHOTO DATA

HELICOPTER AStar TEST DATE 6-8-83

EVENT NO.	EVENT TYPE	TIME OF PHOTO	HEADING (DEGREES)	ALTIMETER (AGL) FT. (METERS)	IAS (KTS)	ROTOR SPEED (RPM OR %)	TORQUE (%)
I300	HIGE	8:05	305	330	0	380	84
I345	HIGE	8:06:04	350	320	0	380	82
I30	HIGE	8:08:37	030	320	0	380	82
I75	HIGE	8:09:12	065	310	0	380	82
I120	HIGE	8:11:52	125	310	0	380	82
I165	HIGE	8:13:51	170	300	0	380	82
I210	HIGE	8:16:57	215	300	0	380	82
I255	HIGE	8:23:31	255	300	0	380	82
J300A	FLT IDLE	8:26:21	300	300	0	370	23
J345A	FLT IDLE	8:26:46	350	300	0	370	22
J030A	FLT IDLE	8:38:54	030	300	0	370	22
J75A	FLT IDLE	8:40:28	080	300	0	370	22
J120A	FLT IDLE	8:42:12	120	300	0	370	22
J120B	GND IDLE	8:45:21	120	310	0	165	10
J165A	FLT IDLE	8:47:58	170	300	0	370	22
J210A	FLT IDLE	8:48:25	210	290	0	370	22
J255A	FLT IDLE	8:50:06	260	300	0	370	22
F1	APPROACH	9:18:39	120	800	67	380	22
F2	APPROACH	9:22:34	125	770	65	380	11
F3	APPROACH	9:25:23	125	740	64	380	28
F4	APPROACH	9:29:04	120	790	69	380	28
F5	APPROACH	9:32:26	120	770	63	380	22

TABLE E.3

COCKPIT PHOTO DATA

HELICOPTER AStar TEST DATE 6-8-83

EVENT NO.	EVENT TYPE	TIME OF PHOTO	HEADING (DEGREES)	ALTIMETER (AGL) FT. (METERS)	IAS (KTS)	ROTOR SPEED (RPM OR %)	TORQUE (%)
C32	500'LFO 0.7	11:34:00	310	800	-	385	70
C33	500'LFO 0.7	11:36:00	-	830	109	385	51
C34	500'LFO 0.7	11:38:11	310	810	100	385	60
C35	500'LFO 0.7	11:40:24	125	810	100	385	62
C36	500'LFO 0.7	11:42:30	310	810	98	385	43
D37	1000'LFO 0.9	11:46:53	120	1250	132	385	84
D38	1000'LFO 0.9	11:46:54	310	1300	128	385	80
D39	1000'LFO 0.9	11:49:22	125	1260	122	385	82
D40	1000'LFO 0.9	11:51:29	310	1310	125	385	71
N41	500'LFO	11:54:06	120	820	140	385	100
N42	500'LFO	11:56:45	310	840	-	385	100
N43	500'LFO	11:58:53	120	830	148	385	100
N44	500'LFO	12:00:35	310	860	140	385	100
M45	500'LFO	12:01:47	125	760	83	385	54
M46	500'LFO	12:04:08	300	800	-	385	-
M47	500'LFO	12:06:23	125	800	83	385	56
M48	500'LFO	12:09:45	310	780	-	380	62
G49	TAKEOFF	12:12:45	310	640	-	380	90
G50	TAKEOFF	12:16:49	310	680	70	380	90
G51	TAKEOFF	12:19:20	310	700	70	380	90
G52	TAKEOFF	12:23:45	310	700	70	380	90
G53	TAKEOFF	12:27:04	305	700	79	380	90
G54	TAKEOFF	12:30:30	305	740	79	380	88

APPENDIX F

Photo-Altitude and Flight Path Trajectory Data

This appendix contains the results of the photo-altitude and flight path trajectory analysis.

The helicopter altitude over a given microphone was determined by a photographic technique which involves photographing an aircraft during a flyover event and proportionally scaling the resulting image with the known dimensions of the aircraft. The data acquisition is described in detail in Section 5.2. The detailed data reduction procedures is set out in Section 6.2.1; the analysis of these data is discussed in Section 8.2

Each table within this appendix provides the following information:

Event No.	the test run number
Est. Alt.	estimated altitude above microphone site
P-Alt.	altitude above photo site, determined by photographic technique
Est. CPA	estimated closest point of approach to microphone site
Est. ANG	Helicopter elevation with respect to the ground as viewed from a sideline site as the helicopter passes through a plane perpendicular to the flight track and coincident with the observer location.
ANG 5-1	flight path slope, expressed in degrees, between P-Alt site 5 and P-Alt site 1.
ANG 1-4	flight path slope, expressed in degrees, between P-Alt Site 1 and P-Alt Site 4.
ANG 5-4	flight path slope, expressed in degrees, between P-Alt Site 5 and P-Alt Site 4.
Reg C/D Angle	flight path slope, expressed in degress, of regression line through P-Alt data points.

TABLE F.1

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER(0.9*VH)/TARGET IAS=130.5 MPH

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					REG.
EVENT NO	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. CPA	ELEV ANG	EST. CPA	ELEV ANG	ANG 5-1	ANG 1-4	ANG 5-4	C/D ANGLE
A22	538.5	529.8	535.7	556.7	533.5	522.5	727.3	47.4	727.6	47.4	3.1	-3.9	-.3	-.2
A23	570.7	567.3	600	592.3	623.4	620.3	775.9	50.6	773.1	50.8	2.9	3.3	3.1	2.7
A24	534.4	527.5	535.8	550.7	536.8	528.2	727.4	47.4	727.3	47.4	2.7	-2.5	0	.1
A25	555.2	550.4	568.6	572.3	579.3	573.9	751.9	49.1	750.6	49.2	2.5	.2	1.4	1.2
A26	513.5	508.5	513.9	525.1	514.2	507.9	711.5	46.2	711.4	46.2	1.9	-1.9	0	0
A27	585.8	581	606.4	606.4	622.9	617.7	780.9	50.9	778.9	51	3	1.3	2.1	1.9
AVERAGE	549.7	544.1	560.1	567.3	568.4	561.8	745.8	48.6	744.8	48.7				
STD. DEV	26.2	27.2	37.8	29.5	47.5	49.5	28.4	1.9	27.2	2				

TABLE F.2

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER(0.8*VH)/TARGET IAS=116 MPH

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					REG.
EVENT NO	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. CPA	ELEV ANG	EST. CPA	ELEV ANG	ANG 5-1	ANG 1-4	ANG 5-4	C/D ANGLE
B28	540.8	536.3	546.7	553.6	551.4	546	735.5	48	734.9	48	2	-.8	.6	.5
B29	552.8	550.4	549.3	556.7	546.5	543.3	737.4	48.2	737.8	48.1	.7	-1.5	-.3	-.2
B30	473.1	474.4	485.5	476	495.4	497.5	691.2	44.6	690.1	44.7	.2	2.5	1.3	1.1
B31	516.8	510.7	534.6	539	548.8	541.9	726.6	47.4	724.9	47.4	3.3	.3	1.8	1.7
AVERAGE	520.9	518	529	531.3	535.5	532.2	722.7	47.1	721.9	47.1				
STD. DEV	35.2	33.4	29.7	37.7	26.8	23.2	21.5	1.7	21.9	1.6				

TABLE F.3

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER(0.7*VH)/TARGET IAS=101.5 MPH

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					REG.
	EST.		EST.		EST.		EST.	ELEV	EST.	ELEV	ANG	ANG	ANG	C/D
EVENT NO	ALT.	P-ALT.	ALT.	P-ALT.	ALT.	P-ALT.	CPA	ANG	CPA	ANG	5-1	1-4	5-4	ANGLE
C32	548.5	550.4	568.5	553.6	584.6	587.8	751.9	49.1	749.9	49.2	.4	4	2.2	1.9
C33	568.8	566	562.8	572.3	558	554.2	747.5	48.8	748.1	48.8	.7	-2	-.6	-.5
C34	544.8	541.8	575.4	566	599.9	597.4	757.1	49.5	754.1	49.6	2.8	3.7	3.2	2.8
C35	548.9	546.7	536	547.7	525.8	522.5	727.6	47.5	728.8	47.4	.1	-2.8	-1.3	-1.1
C36	550.2	546.7	547	556.7	544.5	539.9	735.7	48	736	48	1.2	-1.9	-.3	-.2
AVERAGE	552.2	550.3	558	559.3	562.5	560.4	744	48.6	743.4	48.6				
STD. DEV	9.5	9.3	16.1	9.8	29.9	31.7	12.1	.8	10.6	.9				

TABLE F.4

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 1000 FT.FLYOVER 0.9Vh/TARGET IAS=130.5 MPH

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					REG.
	EST.		EST.		EST.		EST.	ELEV	EST.	ELEV	ANG	ANG	ANG	C/D
EVENT NO	ALT.	P-ALT.	ALT.	P-ALT.	ALT.	P-ALT.	CPA	ANG	CPA	ANG	5-1	1-4	5-4	ANGLE
D37	1013.9	1006.5	1059.9	NA	1087.2	1079.8	1168.5	65.1	1163.2	NA	NA	NA	4.3	4.3
D38	1081.1	1078.7	1075.4	1083.7	1071	1067.3	1182.6	65.4	1183.3	65.4	.6	-1.8	-.5	-.4
D39	1076.1	1041.3	1054.9	1144.6	1038	993.4	1164	65	1166.4	65	11.9	-17	-2.7	-1.9
D40	1087.1	1078.7	1089.6	1107.3	1091.6	1081.1	1195.5	65.7	1195.2	65.7	3.3	-2.9	.1	.2
AVERAGE	1064.6	1051.3	1070	1111.9	1071.9	1055.5	1177.7	65.3	1177	65.4				
STD. DEV	34	34.7	15.7	30.7	24.3	41.8	14.3	.3	15	.4				

TABLE F.5

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: ICAO TAKEOFF/TARGET IAS=63 MPH

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					REG.
EVENT NO	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. CPA	ELEV ANG	EST. CPA	ELEV ANG	ANG 5-1	ANG 1-4	ANG 5-4	C/D ANGLE
E10	425.9	398.9	586.7	562.8	714.9	687.6	765.7	50	750	50.6	18.4	14.2	16.4	14.9
E11	430.8	379.5	674.4	661.5	868.7	814.4	834.8	53.9	809.8	54.6	29.8	17.3	23.8	22.6
E12	461.4	469	528.8	476	582.6	595	722.3	47.1	716	47.3	.8	13.6	7.3	6.3
E13	377.5	346.5	536.5	522.4	663.4	631.1	728	47.5	713.1	48.1	19.7	12.5	16.1	14.8
E14	383.1	355.3	562.5	530.6	705.5	678	747.3	48.8	730.2	49.5	19.6	16.7	18.2	16.7
E15	366.8	336	560.6	527.8	715.1	684.4	745.8	48.7	727.4	49.4	21.3	17.7	19.5	18
E16	410.1	379.5	600.5	569.1	752.3	721.7	776.3	50.7	757.6	51.3	21.1	17.2	19.2	17.7
E17	427.2	395	645.4	402.8	819.4	788	811.5	52.7	789.5	53.4	22.9	20.6	21.8	20.3
AVERAGE	410.3	382.5	586.9	556.6	727.7	700	766.5	49.9	749.2	50.5				
STD. DEV	32.2	41.6	51.4	56.7	88.5	73.6	39.7	2.4	35.1	2.5				

TABLE F.6

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: ICAO 6 DEGREE APPROACH/TARGET IAS=63 MPH

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					REG.
EVENT NO	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. CPA	ELEV ANG	EST. CPA	ELEV ANG	ANG 5-1	ANG 1-4	ANG 5-4	C/D ANGLE
F1	285.9	273.4	347.6	335.1	409.3	NA	602.4	35.2	605.8	NA	7.1	NA	NA	7.1
F2	294.6	283.9	353.6	346.5	400.7	389.8	605.9	35.7	601.5	36	7.3	5	6.1	5.5
F3	308	299.1	365	355	410.4	401.6	612.6	36.6	608.3	36.9	6.5	5.4	5.9	5.3
F4	291.2	280.3	353.9	345.3	403.9	392.9	606.1	35.7	601.4	36.1	7.5	5.5	6.5	5.8
F5	282	272.1	353.9	338.4	411.1	401.6	606	35.7	600.7	36.1	7.7	7.3	7.5	6.7
F6	291	276.2	358.3	356.2	411.9	396.1	608.6	36.1	603.6	36.4	9.2	4.6	6.9	6.2
F7	293.5	280.3	352.6	351.3	399.8	385.6	605.3	35.6	600.9	36	8.2	4	6.1	5.5
F8	301.6	288.3	361.6	360	409.3	395.1	610.6	36.3	606.1	36.6	8.3	4.1	6.2	5.6
F9	298.2	288.3	353.1	346.5	394.9	386.7	605.6	35.7	601.5	36	6.7	4.7	5.7	5.1
AVERAGE	294	282.4	355.5	348.3	405.9	393.7	607	35.8	603.3	36.3				
STD. DEV	7.9	8.6	5.2	8.2	5.7	131.4	3.1	.4	2.8	.3				

TABLE F.7

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: TAKEOFF/TARGET IAS=63 MPH

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					REG.
EVENT NO	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. CPA	ELEV ANG	EST. CPA	ELEV ANG	ANG 5-1	ANG 1-4	ANG 5-4	C/D ANGLE
649	332.3	306	474.5	458.9	587.9	560.7	683.5	44	671	44.6	17.3	11.7	14.5	13.2
650	410.6	383.4	534.8	530.6	633.9	604.9	726.7	47.4	715.1	47.9	16.7	8.6	12.7	11.5
651	432.6	398.5	579.3	578.8	696.3	659.6	760.1	49.7	745.8	50.2	20.1	9.3	11.9	13.6
652	407.6	376.9	564	550.7	688.7	656.6	748.4	48.9	733.4	49.5	19.5	12.1	15.9	14.5
653	413.7	384.7	584.3	559.7	720.3	690.9	763.8	49.9	747.3	50.5	19.6	14.9	17.3	15.8
654	393	367	520.6	511.9	622.3	595	716.3	46.6	704.5	47.1	16.4	9.6	13	11.8
AVERAGE	398.3	369.4	542.9	531.8	658.2	628	733.1	47.8	719.5	48.3				
STD. DEV	34.7	32.7	41.8	42.6	51.1	48.8	30.6	2.2	29.2	2.2				

TABLE F.8

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 9 DEGREE APPROACH/TARGET IAS=63 MPH

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					REG.
EVENT NO	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. CPA	ELEV ANG	EST. CPA	ELEV ANG	ANG 5-1	ANG 1-4	ANG 5-4	C/D ANGLE
H18	302.2	286.8	384.9	375.9	451	435.1	624.7	38	618.2	38.5	10.3	6.9	8.6	7.7
H19	284.1	260.1	391.1	388.8	476.5	450.8	628.5	38.5	620.1	39.1	14.7	7.2	11	9.9
H20	298.7	NA	402.6	385.8	495.5	468.7	635.8	39.3	640.7	NA	NA	9.6	NA	9.6
H21	308.7	292.8	402.5	388.8	477.3	461.3	635.7	39.3	628.1	39.8	11	8.4	9.7	8.7
AVERAGE	298.4	279.9	395.3	384.8	472.6	454	631.2	38.8	626.8	39.1				
STD. DEV	10.4	17.4	8.8	6.1	15	14.6	5.5	.6	10.2	.7				

TABLE F.9

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER/TARGET IAS=86 MPH

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					REG.
EVENT NO	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. CPA	ELEV ANG	EST. CPA	ELEV ANG	ANG 5-1	ANG 1-4	ANG 5-4	C/D ANGLE
M45	497	487.9	485.3	511.9	476	464.2	691.1	44.6	692.1	44.6	2.8	-5.4	-1.3	-1
M46	535.9	522.9	593.5	592.3	639.5	625.6	770.9	50.3	765.2	50.5	8	3.9	6	5.4
M47	551.2	545.4	541.6	559.7	534	526.3	731.7	47.7	732.6	47.7	1.7	-3.8	-1	-.8
M48	508	504.3	532.3	527.8	551.6	548	724.8	47.3	722.6	47.3	2.7	2.4	2.5	2.3
AVERAGE	523	515.1	538.2	547.9	550.3	541	729.6	47.5	728.1	47.5				
STD. DEV	24.9	24.7	44.3	35.6	67.7	66.6	32.7	2.3	30.1	2.4				

TABLE F.10

HELICOPTER: ASTAR

TEST DATE: 6-8-83

OPERATION: 500 FT.FLYOVER/TARGET IAS=143 MPH

	CENTERLINE						SIDELINE							
	MIC #5		MIC #1		MIC #4		MIC #2		MIC #3					REG.
EVENT NO	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. ALT.	P-ALT.	EST. CPA	ELEV ANG	EST. CPA	ELEV ANG	ANG 5-1	ANG 1-4	ANG 5-4	C/D ANGLE
N41	573	571.4	563.9	572.3	556.7	554.3	748.4	48.9	749.3	48.9	.1	-2	-.9	-.7
N42	580.6	574.1	596.8	602.8	609.8	602.4	773.5	50.5	771.9	50.6	3.3	0	1.6	1.5
N43	573	571.4	557.2	569.1	544.5	541.9	743.3	48.6	744.8	48.5	-.2	-3.1	-1.6	-1.4
N44	576.5	578.2	555.5	562.8	538.7	539.9	742	48.5	744	48.4	-1.7	-2.6	-2.1	-1.9
AVERAGE	575.8	573.8	568.3	576.8	562.4	559.6	751.8	49.1	752.5	49.1				
STD. DEV	3.6	3.2	19.3	17.8	32.5	29.2	14.7	.9	13.1	1				

APPENDIX G

NWS Upper Air Meteorological Data

This appendix presents a summary of meteorological data gleaned from National Weather Service radiosonde (rawinsonde) weather balloon ascensions conducted at Sterling, VA. The data collection is further described in Section 5.4. Tables are identified by launch date and launch time. Within each table the following data are provided:

Time	expressed first in Eastern Standard, then in Eastern Daylight Time
Surface Height	height of launch point with respect to sea level
Height	height above ground level, expressed in feet
Pressure	expressed in millibars
Temperature	expressed in degrees centigrade
Relative Humidity	expressed as a percent
Wind Direction	the direction from which the wind is blowing (in degrees)
Wind Speed	expressed in knots

TABLE G.1

DATE: 6 / 8 / 83

TIME: 658 EST FLIGHT # 1 7:58 EDT

SURFACE HEIGHT= 279 FT MSL -999= MISSING DATA

HEIGHT FEET	PRESSURE MB	TEMPERATURE DEG C	RELATIVE HUMIDITY	WIND DIRECTION	WIND SPEED KTS
0	1001.0	17.8	68	340	3
100	997.5	17.5	64	-999	-999
200	993.9	17.4	62	-999	-999
300	990.3	17.3	59	333	8
400	986.8	17.3	56	338	16
500	983.3	17.5	53	343	17
600	979.8	17.7	51	352	14
700	976.4	17.8	49	356	15
800	972.9	17.8	48	358	15
900	969.4	17.8	47	4	13
1000	966.0	17.7	47	6	14
1100	962.6	17.5	47	6	16
1200	959.2	17.4	47	5	17
1300	955.7	17.2	48	8	17
1400	952.3	17.0	48	8	17
1500	948.9	16.8	48	11	15
1600	945.5	16.6	48	9	18
1700	942.2	16.4	48	10	18
1800	938.8	16.1	49	10	18
1900	935.5	15.9	49	13	17
2000	932.2	15.6	49	13	18
2100	928.8	15.4	50	11	20
2200	925.5	15.2	50	12	19
2300	922.2	14.9	50	13	19
2400	918.8	14.7	50	13	19
2500	915.5	14.4	51	12	21
2600	912.2	14.2	51	13	20
2700	908.9	13.9	51	13	19
2800	905.6	13.7	51	5	20
2900	902.4	13.5	52	15	18
3000	899.1	13.2	52	10	18

DATE: 6 / 8 / 83

TABLE G.2

TIME: 729 EST FLIGHT # 2 8:29 EDT

SURFACE HEIGHT= 279 FT MSL -999= MISSING DATA

HEIGHT FEET	PRESSURE MB	TEMPERATURE DEG C	RELATIVE HUMIDITY	WIND DIRECTION	WIND SPEED KTS
0	1001.2	18.9	62	340	5
100	997.6	18.7	58	-999	-999
200	994.1	18.2	58	-999	-999
300	990.6	17.8	58	-999	-999
400	987.1	17.6	57	22	8
500	983.6	17.5	55	345	14
600	980.1	17.4	53	348	18
700	976.6	17.3	52	349	16
800	973.1	17.3	51	352	16
900	969.6	17.4	51	356	16
1000	966.2	17.4	51	2	16
1100	962.7	17.4	50	5	17
1200	959.3	17.5	50	6	17
1300	955.9	17.4	50	8	17
1400	952.5	17.2	50	10	16
1500	949.1	16.9	50	10	18
1600	945.8	16.6	50	10	20
1700	942.4	16.4	50	13	18
1800	939.0	16.1	50	12	18
1900	935.6	15.9	50	14	17
2000	932.3	15.6	50	15	16
2100	928.9	15.3	51	12	18
2200	925.6	15.0	52	11	18
2300	922.3	14.7	52	8	19
2400	919.0	14.4	53	8	21
2500	915.7	14.1	54	6	21
2600	912.4	13.8	55	6	20
2700	909.1	13.5	56	6	21
2800	905.8	13.2	57	4	21
2900	902.5	12.9	58	5	20
3000	899.2	12.8	56	5	20

TABLE G.3

DATE: 6 / 8 / 83

TIME: 801 EST FLIGHT # 3 9:01 EDT

SURFACE HEIGHT= 279 FT MSL -999= MISSING DATA

HEIGHT FEET	PRESSURE MB	TEMPERATURE DEG C	RELATIVE HUMIDITY	WIND DIRECTION	WIND SPEED KTS
0	1001.3	20.0	59	350	6
100	997.8	19.6	52	-999	-999
200	994.2	19.3	50	-999	-999
300	990.7	19.0	51	316	14
400	987.2	18.8	51	345	10
500	983.7	18.5	51	8	8
600	980.2	18.2	52	4	8
700	976.7	18.0	52	352	11
800	973.3	17.8	51	341	15
900	969.9	17.7	51	339	16
1000	966.4	17.5	50	352	15
1100	963.0	17.3	49	8	12
1200	959.5	17.2	49	7	15
1300	956.1	17.0	48	7	16
1400	952.7	16.8	47	9	16
1500	949.2	16.6	47	8	17
1600	945.8	16.4	46	9	17
1700	942.5	16.0	47	8	16
1800	939.1	15.7	47	6	17
1900	935.7	15.4	47	7	16
2000	932.4	15.0	48	5	17
2100	929.0	14.8	49	6	17
2200	925.7	14.5	50	5	18
2300	922.3	14.2	51	3	19
2400	919.0	14.0	52	2	19
2500	915.7	13.8	52	1	19
2600	912.4	13.5	53	4	20
2700	909.1	13.3	53	5	21
2800	905.8	13.1	54	5	21
2900	902.6	12.9	54	5	20
3000	899.3	12.7	54	2	21

DATE: 6 / 8 / 83 TABLE G.4

TIME: 900 EST FLIGHT # 4 10:00 EDT

SURFACE HEIGHT= 279 FT MSL -999= MISSING DATA

HEIGHT FEET	PRESSURE MB	TEMPERATURE DEG C	RELATIVE HUMIDITY	WIND DIRECTION	WIND SPEED KTS
0	1001.6	21.7	53	340	6
100	998.1	20.9	49	-999	-999
200	994.6	20.4	50	-999	-999
300	991.1	20.0	51	19	6
400	987.6	19.6	51	349	8
500	984.1	19.3	51	349	9
600	980.7	18.9	51	350	9
700	977.2	18.6	51	355	9
800	973.7	18.2	51	4	8
900	970.2	17.8	51	11	9
1000	966.8	17.5	51	18	9
1100	963.4	17.2	52	12	8
1200	960.0	17.0	53	2	8
1300	956.6	16.7	54	360	8
1400	953.2	16.4	55	6	8
1500	949.7	16.2	55	12	9
1600	946.3	15.9	56	7	9
1700	942.9	15.6	57	359	11
1800	939.5	15.4	58	354	13
1900	936.1	15.1	59	357	11
2000	932.7	14.8	60	2	10
2100	929.4	14.5	61	1	9
2200	926.0	14.2	62	360	9
2300	922.7	13.8	63	356	9
2400	919.3	13.5	64	349	8
2500	916.0	13.2	65	348	9
2600	912.7	13.0	65	356	11
2700	909.4	12.8	64	360	13
2800	906.2	12.6	64	360	13
2900	902.9	12.4	64	357	14
3000	899.6	12.2	63	355	15

TABLE G.5

DATE: 6 / 8 / 83

TIME: 958 EST FLIGHT # 5 10:58 EDT

SURFACE HEIGHT= 279 FT MSL -999= MISSING DATA

HEIGHT FEET	PRESSURE MB	TEMPERATURE DEG C	RELATIVE HUMIDITY	WIND DIRECTION	WIND SPEED KTS
0	1002.0	21.8	49	330	8
100	998.5	21.4	48	-999	-999
200	995.0	21.0	49	-999	-999
300	991.5	20.7	50	320	10
400	988.0	20.4	50	326	11
500	984.6	20.1	51	332	9
600	981.1	19.8	52	333	7
700	977.6	19.4	52	332	10
800	974.1	19.1	53	335	12
900	970.7	18.8	54	360	9
1000	967.3	18.4	54	354	8
1100	963.8	18.0	55	336	13
1200	960.4	17.7	55	336	14
1300	957.0	17.3	56	343	10
1400	953.6	17.0	56	338	13
1500	950.2	16.7	57	343	13
1600	946.9	16.4	57	342	13
1700	943.5	16.1	58	347	11
1800	940.1	15.7	59	358	7
1900	936.8	15.4	59	2	6
2000	933.4	15.1	60	359	8
2100	930.0	14.8	60	351	9
2200	926.7	14.5	61	341	10
2300	923.3	14.2	61	348	10
2400	919.9	13.9	62	343	9
2500	916.6	13.7	62	335	11
2600	913.3	13.5	63	338	12
2700	910.1	13.4	63	343	10
2800	906.8	13.3	63	351	10
2900	903.5	13.1	64	359	10
3000	900.2	12.9	65	5	11

DATE: 6 / 8 / 83

TABLE G.6

TIME: 1058 EST FLIGHT # 6 11:58 EDT

SURFACE HEIGHT= 279 FT MSL -999= MISSING DATA

HEIGHT FEET	PRESSURE MB	TEMPERATURE DEG C	RELATIVE HUMIDITY	WIND DIRECTION	WIND SPEED KTS
0	1002.2	23.3	49	330	7
100	998.7	24.5	47	-999	-999
200	995.3	24.4	49	-999	-999
300	991.8	24.2	50	-999	-999
400	988.4	23.7	51	46	5
500	984.9	23.3	52	343	6
600	981.5	22.9	53	329	10
700	978.1	22.5	54	327	13
800	974.7	21.8	52	352	12
900	971.3	21.4	53	359	8
1000	967.9	21.0	53	16	7
1100	964.5	20.5	54	349	7
1200	961.1	20.1	55	338	10
1300	957.7	19.7	55	337	12
1400	954.3	19.2	56	334	14
1500	950.9	18.8	56	336	14
1600	947.5	18.4	57	345	12
1700	944.1	18.1	58	339	11
1800	940.8	17.9	58	333	13
1900	937.5	17.7	59	338	12
2000	934.1	17.5	59	343	9
2100	930.8	17.3	60	340	9
2200	927.5	17.1	61	342	12
2300	924.1	16.9	61	340	8
2400	920.8	16.7	62	337	7
2500	917.5	16.5	62	336	13
2600	914.3	16.3	63	334	14
2700	911.1	16.1	64	333	13
2800	907.8	15.9	64	332	12
2900	904.6	15.6	65	331	11
3000	901.3	15.4	66	327	9

APPENDIX H

NWS - IAD Surface Meteorological Data

This appendix presents a summary of meteorological data gleaned from measurements conducted by the National Weather Service Station at Dulles. Readings were noted evey 15 minutes during the test. The data acquisition is described in Section 5.5.

Within each table the following data are provided:

Time(EDT)	time the measurement was taken, expressed in Eastern Daylight Time
Barometric pressure	expressed in inches of mercury
Temperature	expressed in degrees Fahrenheit and centigrade
Humidity	relative, expressed as a percent
Wind Speed	expressed in knots
Wind Direction	direction from which the wind is moving

TABLE H.1

SURFACE METEOROLOGICAL DATA (NWS)

TEST DATE: June 8, 1983 HELICOPTER: AS-350D AStar LOCATION: DULLES AIRPORT*

TIME (EDT)	BAROMETRIC PRESSURE (INCHES)	TEMPERATURE °F(°C)	HUMIDITY (%)	WIND	
				SPEED (MPH)	DIRECTION (DEGREES)
07:49	29.86	64(18)	78	7	330
08:14	29.86	65(18)	75	7	320
08:29	29.86	66(19)	73	7	330
08:46	29.87	68(20)	68	7	320
08:51	29.87	68(20)	68	8	320
09:15	29.87	69(20)	66	7	330
09:31	29.87	70(21)	63	6	350
09:45	29.88	71(22)	61	8	340
09:52	29.88	71(22)	61	8	350
10:14	29.88	71(22)	59	9	330
10:31	29.88	72(22)	57	7	360
10:46	29.89	72(22)	57	10	330
10:54	29.89	73(23)	56	7	350
11:15	29.89	74(23)	54	6	360
11:30	29.89	74(23)	55	12	290
11:48	29.89	73(23)	55	10	320
12:05	29.89	73(23)	55	8	340
12:20	29.89	74(23)	52	7	350
12:35	29.89	74(23)	52	9	330
12:50	29.89	74(23)	52	7	310
1:05	29.89	74(23)	51	8	310

*Sensors located approximately 2 miles east of measurement array

TABLE H.2

SURFACE METEOROLOGICAL DATA (NWS)

TEST DATE: June 8, 1983 HELICOPTER: AS-350D AStar (CONT) LOCATION: DULLES AIRPORT*

TIME (EDT)	BAROMETRIC PRESSURE (INCHES)	TEMPERATURE °F(°C)	HUMIDITY (%)	WIND SPEED (MPH)	WIND DIRECTION (DEGREES)
1:20	29.89	75(24)	51	7	300
1:35	29.89	75(24)	50	6	310
1:50	29.89	76(24)	50	6	310
2:05	29.88	75(24)	50	7	300
2:20	29.88	77(25)	49	4	310
2:35	29.88	77(25)	49	7	300

*Sensors located approximately 2 miles east of measurement array

APPENDIX I

On-Site Meteorological Data

This appendix presents a summary of meteorological data collected on-site by TSC personnel using a climatronics model EWS weather system. The anemometer and temperature sensor were located 5 feet above ground level at noise site 4. The data collection is further described in Section 5.5.

Within each table, the following data are provided:

Time(EDT)	expressed in Eastern Daylight Time
Temperature	expressed in degrees Fahrenheit and centigrade
Humidity	expressed as a percent
Windspeed	expressed in knots
Wind Direction	direction from which the wind is blowing
Remarks	observations concerning cloud cover and visibility

TABLE I.1

SURFACE METEOROLOGICAL DATA

TEST DATE: June 8, 1983 HELICOPTER: AS-350D AStar LOCATION: DULLES, SITE #4*

TIME (EDT)	TEMPERATURE °F(°C)	HUMIDITY (%)	WINDSPEED AVG (MPH)	WINDSPEED RANGE (MPH)	WIND DIRECTION (DEGREES)	REMARKS
06:30	54(12)	90				East-cloudy, west-light haze
06:45	62(17)	78				very wet ground
07:00	72(22)	76				
07:15	80(27)	72				
07:30	82(28)	68				
07:45	80(27)	61				
08:00	80(27)	58				
08:15	82(28)	56				
08:30	82(28)	56				
08:45	82(28)	55				
09:00	82(28)	55				Sunny, few clouds
09:15	82(28)	42				dry grass, wet ground
09:30	82(28)	40				
09:45	82(28)	42				
10:00	80(27)	42				Sunny, few clouds
10:15	79(26)	42				dry grass, wet ground
10:30	78(25)	42				
10:45	81(27)	41				

SENSOR HEIGHT IS 9 FEET ABOVE GROUND

TABLE I.2

SURFACE METEOROLOGICAL DATA

TEST DATE: June 8, 1983 HELICOPTER: AS-350D AStar (CONT) LOCATION: DULLES, SITE #4*

TIME (EDT)	TEMPERATURE °F(°C)	HUMIDITY (%)	WINDSPEED AVG (MPH)	WINDSPEED RANGE (MPH)	WIND DIRECTION (DEGREES)	REMARKS
11:00	82(28)	40				
11:15	83(28)	40				
11:30	83(28)	40				
11:45	83(28)	40				
12:00	84(29)	40				

SENSOR HEIGHT IS 9 FEET ABOVE GROUND

*U.S. GOVERNMENT PRINTING OFFICE : 1984 0-461-816/10080